

Australasian Plant Conservation

BULLETIN OF THE AUSTRALIAN NETWORK FOR PLANT CONSERVATION INC

VOLUME 23 NUMBER 3 • DECEMBER 2014 – FEBRUARY 2015



Plant and animal conservation: you can't have one without the other!

Plant responses to changing climates: seed and seedling growth in *Banksia*

Communicating science. Does social media carve a gap between young and old readers?

Gardens for Wildlife: promoting biodiversity conservation in urban areas

Teaming with volunteers to save our rare flora

And much much more ...

SPECIAL THEME: CONFERENCE EDITION I:
SUSTAINING PLANT DIVERSITY—ADAPTING TO A CHANGING WORLD

ANPC National Office

GPO Box 1777
 Canberra, ACT 2601, Australia
Ph: (02) 6250 9509
Fax: (02) 6250 9528
Email: anpc@anpc.asn.au
Web: www.anpc.asn.au

ANPC Staff

Martin Driver, Jo Lynch, Carly Westbye

ANPC Committee

President David Coates	Vice President Paul Gibson-Roy
Treasurer Merryl Bradley	Secretary Zoë Knapp

Committee Members

Doug Bickerton, Kate Brown,
 Anne Cochrane, Michelle Haby,
 Bob Makinson, Maria Matthes, Helena Mills,
 Mark Richardson, Natalie Tapson

ANPC News

Go to www.anpc.asn.au/resources to read
 the latest newsletters and subscribe.

Australasian Plant Conservation**Editor**

Huw Morgan

Editorial Team

Paul Adam, Anne Cochrane, Michelle Haby,
 Helena Mills and Jo Lynch

Layout & Graphic Design

Siobhan Duffy

Australasian Plant Conservation is produced by the
 ANPC Inc. with assistance from the Australian National
 Botanic Gardens.

Australasian Plant Conservation is printed on
 recycled paper.
 ISSN 1039-6500

**New Zealand Plant Conservation
Network**

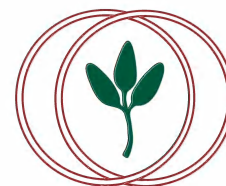
President Sarah Beadel

Secretary Rewi Elliot

PO Box 2199, Wellington, New Zealand

Email: info@nzpcn.org.nz

Web: www.nzpcn.org.nz

**ANPC Inc.
Mission Statement**

*"To promote and improve
 plant conservation"*

**Contributing to Australasian
Plant Conservation**

Australasian Plant Conservation is a
 forum for information exchange for all
 those involved in plant conservation:
 please use it to share your work with
 others. Articles, information snippets,
 details of new publications or
 research, and diary dates are welcome.
 General articles on any plant conservation
 issue are most welcome. **The deadline
 for the March 2015–May 2015 issue
 is Friday 13 February 2014.** The issue
 will be the second to carry articles from
 the 10th Australasian Plant Conservation
 Conference 2014. Please contact the
 editor, Huw Morgan, if you are intending
 to submit an article: editor@anpc.asn.au.

Authors are encouraged to submit images
 with articles or information. Please submit
 images as clear prints, slides, drawings,
 or in electronic format. Electronic images
 need to be at least 300 dpi resolution,
 submitted in at least the size that they are
 to be published, in tif, jpg or gif format.
 Guidelines for authors are at: [http://www.
 anpc.asn.au/apc/APCGuideContrib.pdf](http://www.anpc.asn.au/apc/APCGuideContrib.pdf).

Please send articles, no more
 than 1200 words, as a MS Word
 file (2000 compatible) by email to:
editor@anpc.asn.au.

ANPC Major Sponsors**GOLD SPONSORS**

AUSTRALIAN NATIONAL
 BOTANIC GARDENS

OTHER MAJOR SPONSORS

Opinions expressed in this publication are those of the
 authors and are not necessarily those of the ANPC or
 its sponsors. Material presented in *Australasian Plant
 Conservation* may be copied for personal use or published
 for educational purposes, provided that any extracts are
 fully acknowledged. Where any material is credited to and/
 or copyright to another source, please contact the original
 source for permission to reprint.

Front cover: A conference of Silvereyes
 (*Zosterops lateralis*). Photo: Stuart Smith
Printed by: Trendsetting, Canberra.

Contents

From the editor <i>by Huw Morgan</i>	2
President's Report <i>by David Coates</i>	2
Opening address to the 10th Australasian Plant Conservation Conference 2014 <i>by David Coates</i>	5
Keynote Address: Communicating science. Does social media carve a gap between young and old readers? <i>by Ian Lunt</i>	6
Plenary Lecture: <i>Animals in Plant Conservation</i> subtheme	
Plant and animal conservation: you can't have one without the other! <i>by Jonathan Majer</i>	8
Feral deer damage in Tasmanian restoration plantings <i>by Tanya G Bailey, Archana Gauli, Paul Tilyard, Neil J Davidson, Brad M Potts</i>	10
Understanding plant responses to changing climates: seed germination, seedling emergence and early growth in <i>Banksia</i> <i>by Anne Cochrane, Gemma L. Hoyle, Colin J. Yates and Adrienne B. Nicotra</i>	12
Teaming with volunteers to save our rare flora <i>by Bob Dixon</i>	14
Alpine restoration: identifying needs and determining priorities <i>by Roger Good, Stuart Johnston, Adrienne Nicotra and Jennie Whinam</i>	16
Assessing the risk of gene flow from plantation to native eucalypts: A long-term partnership in biodiversity management <i>by Matthew J Larcombe, Tim Leaman, René E Vaillancourt and Brad M Potts</i>	19
Gardens for Wildlife: promoting biodiversity conservation in urban areas <i>by Iona Mitchell</i>	21
What's killing the trees? Is climate change the cause of Ribbon Gum (<i>Eucalyptus viminalis</i>) dieback in the Monaro region of NSW? <i>by Catherine Ross</i>	23
<i>Azorella macquariensis</i> : battling for survival in the subantarctic <i>by Natalie Tapson</i>	25
Moving from monoculture to multiculture: a history of Bitou Bush on the Tweed Coast, northern NSW <i>by Rhonda James, Tanya Fountain and John Turnbull</i>	27
Considerations for large-scale biodiversity reforestation plantings. Part 2: the planning framework <i>by Dan Cole and Greg Siepen</i>	29

Regular features

ANPC member profile	32
Book review	33
Information resources and useful websites	35
Research roundup	35
ANPC Corporate Members	37

From the editor

Huw Morgan

Welcome to the first of two issues publishing articles from the 10th Australasian Plant Conservation Conference held in Hobart in November 2014. The theme for the conference was *Sustaining Plant Diversity – Adapting to a Changing World*.

It was my pleasure to attend the conference and meet and hear from a range of authoritative, passionate, and distinguished plant conservationists. With over 50 presentations in three concurrent sessions, along with a keynote address and four plenary lectures, the three-day conference was packed full of information and ideas. A highlight of the conference was meeting and hearing from Bob Brown, who spoke powerfully of the present-day importance of conservation, and for the need for conservationists to be bold and unafraid to influence society toward better conservation outcomes. This was accompanied by an unforgettable piano performance of

a jaunty and joyful tune which he wrote some years ago as a young man – a reminder to celebrate life and remain optimistic as we tangle with thorny problems.

At the conference, presentations were grouped according to five sub-themes: *Securing Biodiversity*, *Partnerships for Biodiversity*, *Prioritising Actions*, *Animals in Plant Conservation* and *Engagement and Communication in the Modern World*. I haven't sought to organise the publication of papers by sub-theme – largely for practical reasons, but I also think it makes for less intrusive editing and more interesting reading.

In this issue, don't miss articles from conference Keynote speaker **Ian Lunt** (including an interesting census of conference attendee ages) and Plenary speaker **Jonathan Majer**. There is a big collection of excellent articles from across the country, offering lots of late summer reading. Happy New Year!

President's Report

This is the 23rd year of the ANPC and it is pleasing to see that we continue to maintain our role as Australia's key plant conservation organisation. Submissions to the Threatened Species Commissioner's Draft Terms of Reference and the Senate inquiry into Environmental Biosecurity highlight two key areas where the ANPC has been active this year. The submissions were coordinated by ANPC Committee members Maria Matthes (Threatened Species Commissioner) and Bob Makinson (Biosecurity) and I thank them and a number of other committee members for their efforts in finalising these documents. Following on from the Biosecurity submission, Bob Makinson has been asked to participate in the Senate Environment and Communications References Committee's inquiry into environmental biosecurity. We have also recently entered into a partnership with the Society for Ecological Restoration Australasia (SERA) for the development of a set of National Principles and Standards for the Practice of Ecological Restoration and Rehabilitation.

There continues to be a high level of community interest and support for plant conservation and the ANPC continues to enhance its capacity to play a key role in facilitating and communicating plant conservation initiatives throughout Australia. This is reflected in the sustained level of membership in the ANPC, the ongoing

participation of land managers, government departments, industry, the volunteer conservation movement and the broader community in ANPC workshops and conferences, and the requests we get from other organisations and government to participate in and comment on various flora conservation initiatives.

This year we also completed our new Strategic Plan, which was a priority action at our conference in 2012. The Plan will be circulated to all members prior to the AGM. This is a very important and timely document and I encourage all members to familiarise themselves with what we hope to achieve over the next five years. The Plan outlines our priorities, objectives and strategies for 2014–2019, and more specifically Strategic Actions for July 2014–June 2015. I would particularly like to thank Zoe Knapp, Bob Makinson and Merryl Bradley for preparing the Strategic Plan and all those who provided comments during its drafting.

Importantly this year the ANPC completed a Memorandum of Understanding with the Director of National Parks for the provision of facilities and co-operative arrangements through the Australian National Botanic Gardens. We have a long history of working with the Botanic Gardens and very much appreciate their support in providing facilities to the ANPC.

While I continue to be greatly impressed by the dedication and breadth of knowledge of ANPC members, we still face significant challenges. We need to ensure that we effectively promote the increased recognition among the broader Australian community of the inherent value and cultural significance of native flora. We also need to ensure that we remain focused on our core business of facilitating the conservation of our unique flora, the recovery of threatened species, ecological restoration and the management of remnant vegetation.

2014 Conference APCC10

The 10th national conference of the Australian Network for Plant Conservation (now rebadged as the 10th Australasian Plant Conservation Conference), will be held in Hobart next week. This year's conference theme is *Sustaining Plant Diversity – Adapting to a Changing World*. In 1993 the ANPC held its first national conference in Hobart, with the theme *Cultivating Conservation*, and we very much look forward to celebrating this return to Hobart 21 years later.

This conference will bring together a diverse range of participants including botanists, ecologists, land managers, and on-ground plant conservation managers from around Australia and New Zealand to review and highlight plant conservation achievements and challenges. The conference will also provide a forum to evaluate the strengths and weaknesses of existing approaches, consider current major issues and identify new directions for the coming decades. The sub-themes for this conference (i) Securing Biodiversity, (ii) Partnerships for Biodiversity, (iii) Prioritising Actions, (iv) Animals in Plant Conservation and (v) Engagement and Communication in the Modern World - reflect the many directions and advances in plant conservation in Australia and its surrounds. Perhaps more importantly they reflect the need for participation of a broad range of professional and community groups if realistic on ground advances are going to be made to prevent the extinction of species and conservation of our flora.

I would like to thank the conference organising committee: Lorraine Perrins, Jo Lynch, Mark Fountain, Nick Fountain-Jones, Jennie Whinam, James Wood, Natalie Tapson, Louise Gilfedder, Zoe Knapp and Arin Dean for their huge effort in coordinating the conference. In particular Lorraine Perrins, Jo Lynch and Carly Westbye in the ANPC office, who have worked tirelessly to ensure that the conference will run smoothly and have dealt with the numerous details and issues that have arisen since preparation began more than a year ago.

Workshops, projects and outreach

This year ANPC Project Manager, Tricia Hogbin, delivered two very successful workshops in the Hunter Valley. The first was on plant identification for flora of the Hunter Valley in April and the second was on seed collection, storage and use for native vegetation restoration, also in April. The latter workshop was supported by the

Hunter Local Land Services and was the third based on ANPC's Plant Germplasm Conservation Guidelines. The workshop was attended by a range of stakeholders in plant conservation, with 28 participants and six presenters.

Tricia Hogbin also completed a project with the Sydney Royal Botanic Gardens and Domain Trust contributing to development of the 'Restore and Renew NSW' project which aims to provide an easily accessible source of evolutionary, functional and environmental data directly relevant to the restoration of NSW flora. ANPC's role was to (i) Identify a list of 200-300 plant species considered 'most useful' in restoration projects across NSW, (ii) Collate sources of information used to guide decision making regarding the provenance and fitness of plant material and (iii) identify stakeholders in restoration across NSW.

In late 2013 the ANPC was invited to submit a proposal to the Wimmera Catchment Management Authority for coordination of the Wimmera Orchid Conservation Project in Horsham Victoria. This program implements a range of orchid conservation activities including translocation, pest and animal control, ex-situ conservation of orchid seed and associated mycorrhizal fungi, propagation, monitoring, and threat abatement. We were very excited to be involved with this project and subsequently the ANPC took on the role as project manager with Noushka Reiter employed by the ANPC as the research scientist to implement the project, and Tricia Hogbin to oversee the project as Project Manager. Unfortunately in May this year we were informed that the facility where Noushka had been carrying out the orchid project work would not be available from the end of this year. We are now in the process of finalising an agreement with the Royal Botanic Gardens Melbourne (RBG Melb) to take on the project and they have kindly revamped facilities to house the work. RBG Melb will take over managing the project but ANPC will continue to have close involvement with many aspects of the work. We wish Noushka all the very best with her new position at RBG Melb and she has enthusiastically expressed a strong interest to maintain close links with ANPC.

More broadly our outreach efforts continue to expand through a range of social media with the regular sharing of news and events in plant conservation via Twitter, Facebook, Google+, and LinkedIn. The ANPC News email newsletter is now undergoing a revamp and will soon resume emailing once a month to currently over 760 subscribers.

Our bulletin, *Australasian Plant Conservation*, has continued to publish high-quality articles relevant to a broad range of plant conservation practitioners and managers, under the editorship of Huw Morgan. On behalf of the Committee and all members I would like to sincerely thank Huw for his significant effort in ensuring that APC continues to be a quality and well respected publication for the communication of plant conservation issues in Australia.

Staffing

While we have consolidated our office staff with our Business Manager Jo Lynch and Office Administrator Carly Westbye, we have unfortunately lost Tricia Hogbin as our Project Manager. Tricia has been an outstanding project manager with ANPC and has made a huge contribution not only in terms of workshops and coordinating projects but also through her knowledge brokering, education and communication skills. On behalf of the ANPC I wish Tricia all the very best in her future endeavours.

Tricia will be sadly missed but on a more positive note, I am very pleased to announce that her replacement Martin Driver has an accomplished record in project management and outreach and I am confident he will also do a great job for ANPC. Martin has spent the last thirty years working on private and community vegetation management, enhancement and restoration projects, mostly in NSW and has worked with a wide range of land managers from private landholders, Local Government, State Authorities, and corporate infrastructure companies.

I would like to especially thank Merryl Bradley for the many roles she still plays in supporting the ANPC. While retiring as Business Manager in June last year, Merryl has not only taken on the position of Treasurer but also continues to work as a volunteer in the office.

Movement of the ANPC Head Office was undertaken in June with assistance from the ANBG. The new office is located at the eastern end of the Crosbie Morrison Building at the ANBG, with an improved public profile.

I am again grateful to Committee members for their tremendous support over the year. They all have significant commitments outside the ANPC and it is sometimes challenging to devote the time that they do in maintaining active participation as a committee member. The involvement in the committee by all Committee members is a clear demonstration of their dedication to the ANPC and its goals in improving plant conservation. I also thank Bob Makinson, Helena Mills and Natalie Tapson for agreeing to join the ANPC Committee out of session in February this year.

Funding

Our financial situation will be reported on in detail separately at the AGM but we continue to broaden our sources of income with this year producing a reasonable surplus, comparable to last year and an improvement on the previous year where there was a relatively small surplus.

This year we have been successful with a significant number of grants:

- Hunter Central Rivers Catchment Management Authority Capacity Building Program 2013/14;
- Department of the Environment Grants to Voluntary Environment, Sustainability and Heritage Organisations (GVESHO) for 2013/14;

- NSW Environmental Trust's Lead Environmental Community Groups grant for 2013/14;
- NSW Environmental Trust's Restoration and Rehabilitation Community Grants program for 2013/14 for 'Capacity building in provenance issues for restoration';
- Restore and Renew NSW with RBG Sydney;
- translocation plan for *Persoonia pauciflora*;
- design of recovery actions (augmentation, translocation) for *Asterolasia buxifolia*;
- eleven orchid conservation projects. Most of these will be subcontracted to RBG Melb in 2015; and
- Crowdfunding for the Orchid Conservation Program's new laboratory materials and equipment at RBG Melb.

I would particularly like to thank Jo Lynch and Tricia Hogbin for the great efforts they have put in with these successful grant applications and acknowledge their efforts with six other unsuccessful applications.

The Coming Year

A number of workshops and projects are already in the planning stage by Martin for next year. These include:

- six provenance issues workshops with Local Lands Services (LLS) in NSW funded through the Environment Trust (Restoration & Rehabilitation);
- investigating the options and liaising with Greening Australia (GA) Victoria for funding and delivery of a similar series of provenance issues workshops in regional Victoria;
- collaborating with GA (Capital Region) on the development of an Environment Trust R&R joint partnership project submission for White Cypress Pine rehabilitation in the western Riverina;
- coordinating the delivery of a workshop to investigate the needs, options and funding for a series of seed production areas (SPAs) for *Banksia marginata* in northern Victoria; and
- investigating the opportunity for coastal rainforest species ID workshops.

We also hope to soon finalise the ANPC Prospectus to seek new funding and sponsorship opportunities from relevant companies and organisations.

Finally there is our 10th Australasian Plant Conservation Conference held in Hobart. This is the ANPC's primary event for this year. I very much look forward to meeting many of you and I see this conference as a unique opportunity to bring together members and those interested in plant conservation from across Australia and New Zealand.

David Coates
President

Australian Network for Plant Conservation Inc.

5 November 2014

Opening address to the 10th Australasian Plant Conservation Conference 2014

David Coates

President, Australian Network for Plant Conservation.

Welcome to the Australian Network for Plant Conservation's 10th Australasian Plant Conservation Conference. 2014 is the ANPC's twenty third year of promoting and working for plant conservation in Australia. In 1993 the ANPC held its first national conference in Hobart with the theme of 'Cultivating Conservation'. We very much look forward to celebrating this return to Hobart 21 years later.

The theme for this conference is *Sustaining Plant Diversity – Adapting to a Changing World*. When considering this theme it is of interest to look back at how the ANPC has developed as Australia's key plant conservation organisation. In 1991 the Australian National Botanic Gardens in Canberra acted to co-ordinate the *ex situ* conservation of rare and threatened plants by organising the conference "*Protective Custody? Ex Situ Plant Conservation in Australasia*". The conference had among its primary outcomes the intention to encourage communication and networking so that the diverse range of groups involved in plant conservation can be better informed and coordinate their efforts. Out of this came a proposal for the establishment of the Australian Network for Plant Conservation. While the initial focus of the ANPC was *ex situ* conservation, this rapidly evolved to encompass all aspects of plant conservation and in particular bridged the gap between *ex situ* and *in situ* conservation approaches.

The ANPC is unique in Australia in many ways as an organisation. It consists of a diverse range of members including scientists, land managers, State and Commonwealth Departments, industry, the volunteer conservation movement and the broader community dedicated specifically to the conservation of plant species communities and ecosystems and plays a key role in promoting linkages between all these interest groups. For example, the ANPC maintains Australia's only non-government website dedicated to plant conservation knowledge.

The ANPC has held regular National Conferences addressing a broad range of key biodiversity conservation issues such as invasive species, habitat fragmentation, threatened species and communities, and urban expansion. It is interesting to note that while all these issues still prevail as major concerns in plant conservation we now face new significant challenges. These include the threat of climate change and extensive habitat degradation,

how we might deal with the technological demands of broad scale restoration and the successful translocation or re-introduction of species under rapidly changing environmental scenarios.

This conference will bring together a diverse range of stakeholders to explore, review and highlight plant conservation achievements in Australia over the last two decades, evaluate the strengths and weaknesses of our existing approaches, consider current major issues and identify new directions in Australia for the coming decades. The sub-themes for this conference (i) Securing Biodiversity, (ii) Partnerships for Biodiversity, (iii) Prioritising Actions, (iv) Animals in Plant Conservation and (v) Engagement and Communication in the Modern World reflect the many directions and advances in plant conservation in Australia and its surrounds. Perhaps more importantly they reflect the need for participation of a broad range of professional and community groups if realistic on ground advances are going to be made to prevent the extinction of species and conservation of our flora.

On behalf of the ANPC I'd like to thank the conference sponsors who have made this event possible: in particular our major sponsors the Royal Tasmanian Botanic Gardens, Cradle Mountain Hotel, Freycinet Lodge, The Maria Island Walk, The Old Woolstore Apartment Hotel, Natural Area Consulting Management Services, Business Events Tasmania and the Earth Welfare Foundation. These organisations have recognised the value of supporting the ANPC in facilitating communication and networking among scientists, land managers, community groups, government and industry for improved flora conservation in Australia.

This is going to be an excellent conference and on behalf of the entire ANPC membership I would like to thank the Conference Organising Committee and especially Mark Fountain, Lorraine Perrins, Natalie Tapson and Arin Dean from the RTBG, as well as the ANPC Head Office staff Jo Lynch, Carly Westbye and Merryl Bradley. They have worked tirelessly to ensure that this conference will be a success and more importantly that the findings from the conference are translated into successful flora conservation initiatives and outcomes.

Keynote Address

Communicating science. Does social media carve a gap between young and old readers?

Ian Lunt

Associate Professor in Vegetation Ecology, Charles Sturt University, Albury. Email: ilunt@csu.edu.au

This workshop is great but how do we get this information out of you scientists when we get back home?

This question has been asked at nearly every community workshop I've ever attended. It highlights an enormous appetite for information. Yet I was surprised at a recent workshop when the question was answered by a member of the audience, like this:

There's heaps of great information by scientists on social media, on Facebook, Twitter and blogs.

It may not surprise you to learn that the person who asked the question was in their 50s and the person who answered it was in their 20s. (I hope I guessed both ages appropriately).

The exchange raises lots of questions about access to information on the web. Does social media create a digital divide across the generations? Do crowd sourcing and citizen science initiatives that rely on smartphones exclude sectors of society? *Who's in the tent, and who misses out?*

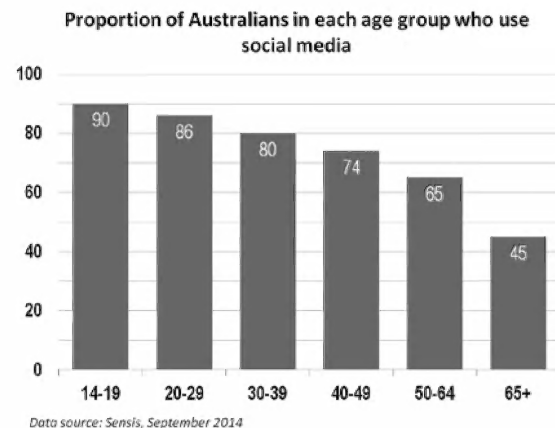
Diving for data

To answer these questions I searched the web for reliable data on social media and smartphone usage in Australia. Whoa, what a mistake that was! Who'd have guessed that the web would be chock-full of awe-inspiring bulldust about technology.

Eventually, I came across good information in reports by Sensis, the company that makes White and Yellow Pages phone directories. The *Sensis e-Business Report* (Sensis 2014a) and *Yellow Social Media Report* (Sensis 2014b) are based on well designed, stratified random telephone surveys of Australians aged 14 and older. All the statistics below exclude children younger than 14.

Who does – and doesn't – use social media?

According to the latest *Sensis e-Business Report* (Sensis 2014a), seven out of ten Australians (72%) aged 14 and above use social media. That's over 13 million people. Almost all of them (95%) use Facebook (Sensis 2014b). We can flip this impressive statistic on its head to investigate the demographic divide (see chart *Proportion of Australians in each age group who use social media*). Who are the 28% of Australian adults who *don't* use social media?



Proportion of Australians in each age group who use social media. Data: Sensis (2014).

Not surprisingly, the factor that most strongly influences whether we choose to use social media is our age (Sensis 2014b). Almost everyone from 14 to 30 uses it. This declines to 65% of 50-64 year olds, and only 45% of Australians over 65.

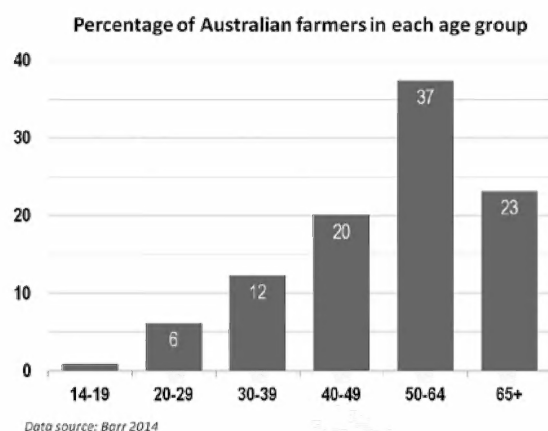
The number of people in the Australian population aged 65 and above is roughly the same as the number of people aged 20-29, 30-39 or 40-49; about 3 million (Australian Bureau of Statistics 2014). This means that 1.8 million Australians over 65 don't use social media. So we definitely do have a demographic divide in the availability of information presented through social media.

Mind you, the fact that 45% of people over 65 do use social media is a surprise, given how youthful Facebook is. It's only 10 years old.

Social media in the bush

Many natural resource management (NRM) groups provide information to farmers. Is social media a useful tool for this purpose?

The popular stereotype is that Australian farmers are getting a bit long in the tooth. If true then we might expect fewer farmers will use social media compared to other sectors of the community, simply because of their age. But is this stereotype accurate?



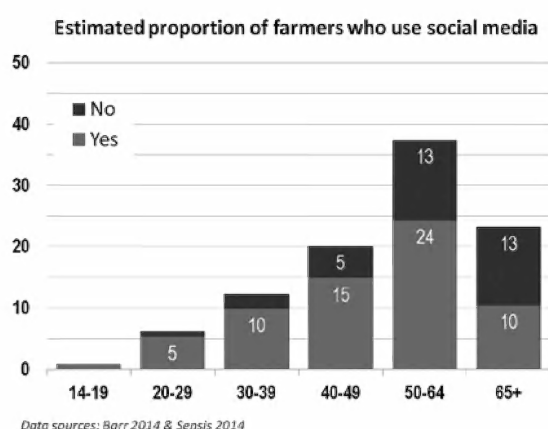
Percentage of Australian farmers in each age group.
Data: Barr (2014).

A recent report by Neil Barr (Barr 2014) provides accurate figures on the age of Australian farmers. Compared to the entire population, farmers are indeed getting on in years (see chart *Percentage of Australian farmers in each age group*). Only 7% are under 30, 60% are over 50, and nearly a quarter are over 65. Mind you, this age structure is similar to that for CEOs of large businesses (Barr 2014), and we wouldn't expect many 15 year olds to be running a large farm business.

How many farmers use social media?

Unfortunately, the number of farmers who use social media is unknown. However we do know that a similar proportion of people use social media in both metropolitan and regional areas (Sensis 2014b).

If we assume that farmers of a particular age are as likely to use social media as any other person of the same age, then we can combine the Sensis (2014a) and Barr (2014) datasets to estimate the overall proportion of farmers who use social media, as in the chart *Estimated proportion of farmers who use social media*.



Estimated proportion of farmers who use social media.
Data: Barr (2014) and Sensis (2014).

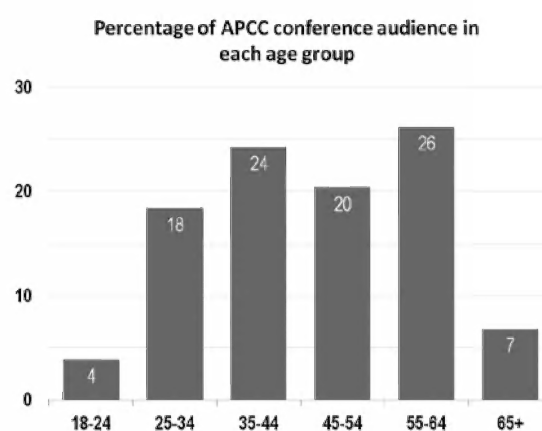
By this estimate, over half of Australian farmers (65%) are likely to use social media compared to 72% of the wider Australian population. The suggestion that fewer farmers use social media compared to all Australian adults is simply a function of their greater age. The key point is:

If we want to know who does and who doesn't access information through social media, it's not an issue of where people live, or what people do, it's mostly a question of how old they are. The young do, the aged might.

How old are we?

It's one thing to talk about everybody else's age, but how old are we? How does the age profile of ANPC members compare against the community at large or farmers in particular?

The ANPC doesn't ask members how old they are, but attendees at the 2014 conference in Hobart volunteered their age, as shown in the chart *Percentage of APCC conference audience in each age group*. All age groups from 25 to 65 were well represented. However the paucity of young (under 25) and older (over 65) attendees is notable.



Percentage of 10th Australasian Plant Conservation Conference audience in each age group.

Does this digital divide matter?

How you answer this question will depend on how old you are and, regardless of your age, on whether or not you own a smartphone and use social media. I make no suggestion that everybody should use social media, or read blogs for that matter. Most people who don't simply don't want to (Sensis 2014b).

Importantly, *information producers* like me must always remember who our audience is, and distribute information in ways that suit that audience. As *information consumers*, we all need to acknowledge that more and more information is being distributed through social media, and this trend is not likely to slow down. A reluctance to use social media may mean we miss out on information that others have ready access to.

And we should always base our judgements on good data, so we can avoid being swayed by all that unfounded, awe-inspiring bulldust on the internet.

A version of this article was originally published in Ian Lunt's Ecology for Australia blog: www.ianluntecology.com

References

Australian Bureau of Statistics (2014). ABS.Stat (online census data). Accessed December 2014 from <http://stat.abs.gov.au/Index.aspx>

Barr, N. (2014). *New entrants to Australian agricultural industries – Where are the young farmers?* Rural Industries Research and Development Corporation. Available from <https://rirdc.infoservices.com.au/items/14-003>

Sensis (2014a). *Sensis e-Business Report 2014. The online experience of small and medium enterprises*. Accessed December 2014 from www.sensis.com.au/about/reports/sensis-ebusiness-report

Sensis (2014b). *Yellow Social Media Report. What Australian people and businesses are doing with social media*. Accessed December 2014 from www.yellowadvertising.com.au/knowledge/insights/Yellow-Social-Media-Report-2014.html

Plenary Lecture: *Animals in Plant Conservation* sub-theme Plant and animal conservation: you can't have one without the other!

Jonathan Majer

Curtin University and Biomonitoring International Pty Ltd. Email: Jonathan.Majer@biomonitoringinternational.com

Summary

For every plant species in Australia there exists around an order of magnitude more animal species. Conservation of animals is as important as that of plants because of utilitarian reasons, moral obligations, legislative requirements and the essential role of animals in the structuring and functioning of ecosystems. In this article, I provide examples of how animals contribute to various ecosystem functions and processes, and note the potential for using animals to monitor the efficacy of plant conservation efforts. I conclude that plant and animal conservation are intertwined activities and must be considered together.

The context

The San Lorenzo Forest is a 6000 ha area of forest in Panama. A team of 102 invertebrate scientists surveyed the entire arthropod fauna in a half hectare subset of this forest and identified 6144 species (Basset et al. 2012). Extrapolating this count to the entire forest resulted in an estimate of 25 000 arthropod species. This compared with 1294 vascular plant species and around 400 species of vertebrate; for every plant species there were at least 20 animal species present. Closer to home, a 10 year study of invertebrates on Barrow Island, a spinifex-dominated island off the coast of northwest WA, revealed 2500 species of invertebrates (Majer et al. 2013), compared with

176 vertebrate and 378 plant species. This equates to seven species of animal for every species of plant.

With a preponderance of animal species in plant environments, it is obvious that the welfare and hence conservation of plants will in some way be influenced by the fauna of the area; in short, fauna have to be considered during the conservation process. ANPC's focus is the conservation of plants – whether a recovery plan for an individual species, or a restoration plan for the conservation of an entire community – there is no reason why animals should receive less attention than plants in conservation planning and implementation. There are a number of reasons for this.

Firstly, there are moral arguments; we have a moral obligation to ensure the survival of all species, from charismatic mammals down to the smallest Guildford springtail (a minute insect-like animal). This is realised by plant conservers, who dedicate considerable attention to the smallest orchid, so why not do the same for the smallest ant? What is the difference? None. Secondly, and more selfishly, there are utilitarian arguments; any species in this world may possess some attribute that is of value or importance to our own lives. If the species is gone, we have lost the opportunity to harness this. Some Australian ants produce chemicals with fungicidal properties, providing opportunities for new generation

of pharmaceuticals. Other ants have interesting foraging strategies; biomimicry experts have learned from these to develop more streamlined airport baggage systems.

Role of animals in ecosystems

A recent survey of the literature (Ollerton et al. 2011) indicated that 78% and 94%, respectively, of vascular plants in temperate and tropical zones are pollinated by animals. Although many plants can be pollinated by a range of species, some have very specific relationships with one type of pollinator. There is no certainty that the correct pollinator will be present when needed by the plant, either due to deficiencies in the required habitat of the pollinator or due to a mismatch in timing of flowering and pollinator activity as a result of climate change.

Dispersal of propagules is essential for success of the next generation of plants. This is because dispersal prevents competition of the seedling with its parent, encourages gene flow and increases the likelihood that propagules will establish in suitable microsites. Ants are notoriously important in the life of hundreds of species of plants in this country. Seeds with oily appendages called elaiosomes are attractive to ants, which take them to their nest and consume the appendage. In doing so, the seed benefits by dispersal, by being planted in nutrient rich soil and by protection from seed predators, desiccation and fire when buried beneath the soil surface. It follows that the absence or failure of suitable dispersing agents could also result in failures of plants to produce future generations.

Australian soils are notoriously low in nutrients, so it is imperative that organic matter is broken down in order to allow the return of nutrients to the soil for future plant growth. Additionally, efficient decomposition of the litter layer reduces build-up of fuels and hence fire hazard. Invertebrates such as worms, springtails, millipedes and termites play an important role in this and augment the role of micro-organisms. However, it's not only the nutrient status of the soil that is important, the structure

of the soil also influences the vegetation. If rainwater does not soak in it will run off, leaving roots of plants starved of water. Similarly, if soil is not aerated, root respiration may be impeded. The activity of soil 'engineers' such as worms, beetles and, particularly in this country, ants, enhances root penetration, water infiltration and produces a generally suitable soil structure, as well as dispersing nutrients to where plants need them. There is plenty of evidence that failing to look after the soil can lead to a depauperate soil fauna and dramatic reductions in soil structure (e.g. Abbott et al. 1979).

No one concerned with the conservation of a rare plant wants to see their efforts ruined by the activities of herbivores. Although this threat can be minimised by chemicals or physical barriers, the activities of thousands of species of parasitic wasps and numerous predator arthropods can keep this in check. A meta-data review by Schmitz et al. (2000) showed that such animals produce top-down effects on the food chain often, but not always, reducing the abundance of herbivores and promoting plant growth. Recent work by Zhao et al. (2013) in China has indicated that the presence of carabid beetles can cause earthworms to move to deeper soil, leading to enhanced nutrient availability at depths required by plants, which promoted plant growth.

Many of the plant-focussed papers at the 2014 Australasian Plant Conservation Conference addressed issues where a consideration of animals has considerable relevance. Some contributions considered monitoring of the success of plant restoration or conservation efforts. It is true that an assessment of floristics can provide much information. However, this may not include information on the health or vigour of certain plants, the ability of species to reproduce and disperse, the characteristics of the decomposer system and also the stratification or patchiness of the vegetation. Surveys of organisms such as ants, beetles, true bugs or spiders are increasingly used as bioindicators in restoration and conservation projects (Majer et al. 2007).



Left: *Rhytidoponera* ant carrying elaiosome-bearing seed. Photo: Benoit Guénard. Right: Heated nest of the same species (inner rectangular area), showing seedlings germinating on surface. Photo: Jonathan Majer.

This is just a brief review of the importance of animals, both invertebrate and vertebrate, in the conservation of plants. Hopefully readers will now be aware that plant and animal conservation are inter-twined – you can't have one without the other.

References

- Abbott, I., Parker, C. A. and Sills, I. D. (1979). Changes in the abundance of large soil animals and physical properties of soils following cultivation. *Australian Journal of Soil Research* 17, 343-353.
- Basset Y. et al. (2012). Arthropod diversity in a tropical forest. *Science* 1338, 1481.
- Borer E. T., Seabloom, E. W., Grunner, D. S. Crawley M. J. et al (2014). Herbivores and nutrients control grassland plant diversity via light limitation. *Nature* 508(7497), 517.
- Majer, J. D., Orabi, G. and Bisevac, L. (2007). Ants (Hymenoptera: Formicidae) pass the bioindicator scorecard. *Myrmecological Notes* 10, 60-76.
- Majer J.D., Callan, S. K., Edwards, K., Gunawardene, N. R. and Taylor, C. K. (2013). Baseline survey of the terrestrial invertebrate fauna of Barrow Island. *Records of the Western Australian Museum Supplement* 83, 13-112.
- Ollerton, J., Winfree, R. and Tarrant, S. (2011). How many flowering plants are pollinated by animals? *Oikos* 120, 321-326.
- Schmitz O. J., Hamback, P. A. and Baeckerman, A. P. (2000). Trophic cascades in terrestrial systems: a review of the effects of carnivore removal on plants. *American Naturalist* 155, 141-153.
- Zhao C., Griffin, J. N., Wu, X and Sun, S. (2013). Predatory beetles facilitate plant growth by driving earthworms to lower soil levels. *Journal of Animal Ecology* 83, 749-758.

Feral deer damage in Tasmanian restoration plantings

Tanya G Bailey^{1,2,*}, Archana Gauli¹, Paul Tilyard¹, Neil J Davidson^{1,2}, Brad M Potts¹

¹ School of Biological Sciences and National Centre for Future Forest Industries, University of Tasmania. ² Greening Australia Tasmania.

*Corresponding author email: Tanya.Bailey@utas.edu.au

A network of field trials using key native eucalypt and shrub species has been embedded in an environmental restoration project in the Tasmanian Midlands and Derwent Valley. The project, a partnership between the University of Tasmania and Greening Australia, aims to:

- build ecological resilience into modified agricultural land by expanding and reconnecting native woodlands on private land;
- develop permanent restoration demonstration and research sites; and
- study the importance of genetic variation within eucalypt species in the success and resilience of environmental plantings.

During 2010 and 2011, restoration plantings were established at 30 ha sites on each of three farms (Dungrove, Grassy Hut and Meadowbank) in the Southern Midlands and Derwent Valley. These plantings were positioned to maximise connectivity within a fragmented landscape with over 30 000 plants per site. The embedded research trials include:

- a Genetics Trial of 8 replicates of single-tree plots of families of Snow Gum (*Eucalyptus pauciflora*) from 37 Tasmanian and 15 mainland Australia provenances (blocks G1-G8 in map; Bailey et al. 2013);

- a Provenance Trial of 6 replicates of 25 tree provenance/species plots of 10 provenances each of Tasmanian Snow Gum (*E. pauciflora*) and Silver Peppermint (*E. tenuiramis*) (single number blocks in map); and
- an Ecology Trial with 8 replicates of 14 treatments in blocks of 120 plants of Snow Gum and/or Silver Peppermint in monocultures or alternated with *Acacia*, *Allocasuarina*, *Cassinia*, *Helichrysum* or Shining Gum (*E. nitens*) plus understorey species (blocks 1.1–8.14 in map).

Performance and health of the plants have been monitored on a regular basis. Approximately 16 months after planting, damage to planted seedlings by feral, but legally protected, Fallow Deer (*Dama dama*) was noted at the first trial site (Dungrove, established in October 2010). The number of trees damaged by deer was recorded in all subsequent assessments. Damage appeared to be caused by males rubbing their heads on stems during antler shedding rather than by browsing, and included stripped bark, snapped branches and some deaths.

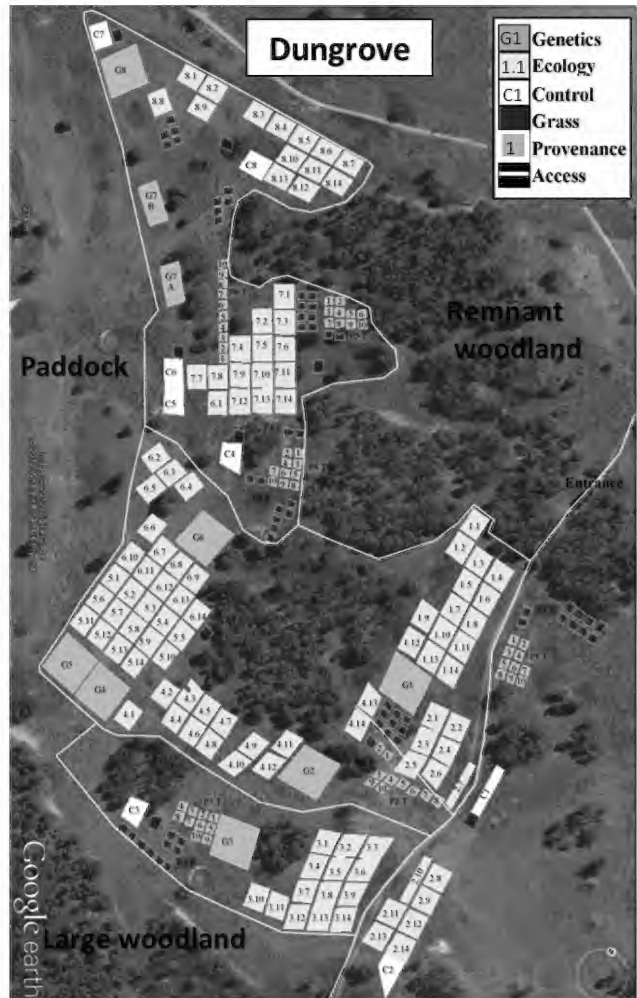
Extent of deer damage

From April to November 2012, the percentage of trees exhibiting damage in the Snow Gum Genetics Trial increased from 2% to 18%. By May 2013 (2.5 years after

planting), 33% of trees had received damage in one or other year and 2% had died. Damage and deaths were greatest in the replicates closest to the edge of the site adjacent to large open paddocks (blocks G4, G5, G7 and G8 in map).

The Ecology Trial was assessed for deer damage two years and two months after planting (December 2012). Replicate 6 (blocks E6.1-E6.14 in map) suffered a statistically significant greater amount of damage than any other replicate and was also mainly adjacent to the paddock edge. There was also a significant difference between species in the percentage of plants affected by deer damage within the whole Ecology Trial. The woody shrub species *Helichrysum* (70% plants damaged) and *Cassinia* (58%) and the fast growing Shining Gum (68%) were two to four times more affected than Silver Peppermint (26%) and Snow Gum (17%). Individuals of *Acacia* and *Allocasuarina* were least damaged but this may be due to these species' overall poor survival. Deer damage to the eucalypts was not influenced by the presence of other non-eucalypt species as there were no significant differences in damage between treatments in which the eucalypts were growing in monocultures and when they were growing with other species.

The Provenance Trial block plantings of Silver Peppermint and Snow Gum, assessed three years and three months after planting (in February 2014), showed that Silver Peppermint (36% of plants damaged) was more susceptible to rubbing damage than Snow Gum (18%). Silver Peppermint plants were taller and a higher percentage of these trees were assessed as having been killed by deer (5%), compared with Snow Gum (2%). There was a significant difference in the percentage of plants damaged by deer among provenances for Silver Peppermint but not for Snow Gum. The local Dungrove population of Silver Peppermint was the most



Map of Dungrove Research Site experiment, showing layout of blocks for the Genetics, Ecology and Provenance growth trials. The site was established in October 2010.



Examples of deer damage on young eucalypts at Dungrove. Photos: T. Bailey.

affected by deer damage, with 45% of trees damaged, and there was a trend for decreasing number of damaged trees with increasing geographical distance of the provenance from Dungrove.

In the Snow Gum Genetics Trial, in which provenances were randomly scattered throughout the replicates (compared to the Provenance Trial in which they were planted in plots), there were significant provenance differences in deer damage in May 2012, however those differences were no longer significant six months later. Gauli (2014) found that the May 2012 provenance differences were due to the deer damage being greater on the faster growing, low altitude provenances.

Control of deer

In Tasmania, Fallow Deer are partly protected under the *Wildlife (General) Regulations 2010* (DPIPWE 2014), and are subject to an open season during which restricted numbers may be shot by licensed hunters. The regulations also provide for culling Fallow Deer under permit on specified land for crop protection, however these measures have proven to be insufficient to reduce deer numbers to prevent damage to young trees at Dungrove. Modelling by Potts et al. (in press) suggests that without active management beyond the current policy of hunting and crop protection permits, abundance of Fallow Deer may increase by 39% from an estimated current population of 20 000 in the next 10 years. Uncontrolled, the population could exceed 1 million animals by 2050.

Implications for restoration

The Northern Tasmanian Midlands region is a nationally recognised biodiversity hotspot in need of conservation and restoration. Greening Australia has recently undertaken 1000 ha of restoration and environmental plantings with embedded field trials in the Northern Midlands at Ross and Cressy. These sites are in relatively low altitude warm areas with high deer numbers. With limited options for large scale control of deer, deer-proof fencing and substantial wire caging have been installed around recent plantings at considerable cost. Providing protection from deer will significantly increase the cost of restoration programs.

References

- Bailey, T., Davidson, N., Potts, B., Gauli, A., Hovenden, M., Burgess, S. and Duddles, J. (2013). Plantings for carbon, biodiversity and restoration in dry rural landscapes. *Australian Forest Grower* 35: 39-41.
- Department of Primary Industries, Parks, Water and Environment (DPIPWE). (2014). *Species Risk Assessment: Fallow Deer*. Downloaded 10 December 2014 from: <http://dipwe.tas.gov.au/wildlife-management/management-of-wildlife/wildlife-imports/species-risk-assessments/fallow-deer>
- Gauli, A. (2014). Genetic diversity and adaptation in *Eucalyptus pauciflora*. PhD Thesis, University of Tasmania.
- Potts, J., Beeton, N., Bowman, D., Williamson, G., Lefroy, E. and Johnson, C. (in press). Predicting the future range and abundance of fallow deer in Tasmania, Australia. *Wildlife Research*.

Understanding plant responses to changing climates: seed germination, seedling emergence and early growth in *Banksia*

Anne Cochran^{1,2,*}, Gemma L. Hoyle¹, Colin J. Yates² and Adrienne B. Nicotra¹

¹ Evolution, Ecology and Genetics, Research School of Biology, The Australian National University, Canberra, ACT 0200, Australia.

² Science and Conservation Division, Department of Parks and Wildlife, Western Australia 6983 Australia.

*Corresponding author: E-mail: anne.cochrane@dpaw.wa.gov.au

A changing climate can impact on plant recruitment and community dynamics

There is mounting evidence to suggest that climate warming will impact heavily on plant diversity by disrupting environmental cues for germination (Walck et al. 2011) and alterations in early seedling growth (Nemani et al. 2003). Key functional traits that influence a plant's ability to cope with change during these early stages of a it's life cycle include: seed mass; rate of seed germination and seedling emergence; seedling survival and growth; and the allocation of leaf and stem biomass. These readily

measurable plant traits interact with the surrounding biotic and abiotic environment. As these traits can directly affect ecosystem processes and are clearly linked to extinction risk, they can be used to help predict the impacts of global change on the dynamics of plant performance.

We used a series of experiments to explore variation in commonly measured functional traits in four plant's (*Banksia baxteri*, *B. coccinea*, *B. media* and *B. quercifolia*; Proteaceae) endemic to the bio-diverse but highly threatened Mediterranean-climate ecosystem of South-Western Australia. These obligate seeding,

serotinous species are considered highly vulnerable to the effects of a changing climate: seeds are released from woody fruits by fire and germinate in the next wet season (or perish), whilst parent plants are killed by fire. Shortened fire intervals, and a drying climate can impact heavily on these plant functional types.

Seeds were collected from multiple populations of each species along a climate gradient – from warm and dry to cool and wet. These seeds were used in two laboratory and one common garden field experiment, and 7-month old seedlings grown from the seed were used in a glasshouse experiment. We subjected seed and seedlings to experimentally induced heat and/or drought stress and measured their responses. We hypothesised that populations at the warm, dry end of the climate gradient would respond more favourably to heat and drought stress during germination and early seedling growth relative to populations from the cool, wet end of the gradient.



Common garden field experiment. Photo: Anne Cochrane.

Flexible but not locally adapted

Evidence gathered from these experiments demonstrates that species traits vary predictably along environmental gradients, and secondly, that warming and drought, in isolation or in combination, affect important stages of the *Banksia* life cycle, and that plants can alter functional traits in response to these conditions. Importantly, these investigations provide independent verification that population responses can vary along environmental gradients.

The most common response to warming and drought for seeds was one of delayed and reduced germination, and this was generally consistent across investigations (Cochrane et al. 2014a, 2014b, 2014c). Delaying germination can place seedlings closer to the summer dry in already seasonally dry climates and therefore increases the chance of desiccation; a decline in total germination increases the risk of population extinction in the future. For seedling leaf traits, regulation of water loss was commonly expressed through a reduction in specific leaf area, leaf size and leaf number, resulting in a reduction in biomass in response to either drought or heat (Cochrane et al. 2014c, 2014d).



Banksia baxteri and *B. coccinea* grown under contrasting temperature and moisture conditions in a glasshouse. Photo: Anne Cochrane.

Banksia quercifolia demonstrated the ability to emerge fast under cool moist conditions; but emerging quickly may be a trade-off against reduced seed tolerance to warming as this species exhibited the steepest decline in the proportion of seedlings to emerge under warmer soils and also suffered the greatest delay in emergence response relative to the control.

Banksia baxteri showed least delay under warmed conditions but also had a longer emergence time under control conditions. However *B. quercifolia* had a greater temperature range for germination than *B. baxteri* and demonstrated minimal decline in germination under drought stress at high temperature whereas the decline in germination was greater in *B. baxteri*.

Banksia media consistently demonstrated least vulnerability to decline in performance when exposed to heat and drought stress, exhibiting a wide temperature and moisture window for germination under controlled conditions and greater percentage emergence in a common garden.

There was evidence that *B. coccinea* may tolerate a drying climate better than other species; although starting from low baseline germination, under warmer soil conditions in the common garden this species demonstrated least decline in germination *per se*. However, some populations of this species may already be close to their optimal temperature and moisture conditions, and rising temperatures and drought as predicted for the region may cause severe declines in plant numbers.

Against expectations, variation in traits expressed by the different populations was not reliably associated with geographical location on the rainfall gradient, suggesting that selection for local adaptation in response to water availability or other climate factors has been minimal. The premise that populations from the dry end of the gradient of each species distribution would demonstrate greater homeostasis of germination or growth was in the main unfounded.

Practical implications

For plants to persist in a changing environment they must be flexible in how they respond to the environment they are exposed to. Species expressing phenotypic variation along environmental gradients may have greater capacity to respond to global change. Even though trait variability was generally greater between the species than among populations of a species, the data gathered in these experiments support the view that using a single mean trait value to describe species has the potential to mask functional variation within species, ignoring the population as an evolutionary unit.

In the context of ecological restoration, knowing that a population can tolerate conditions for germination and growth that are warmer and/or drier than currently experienced can assist in the identification of appropriate sites for restoration and inform the selection of seed material for use in climates that have no current analogue. Incorporating populations that express variation in responsiveness to environmental heterogeneity may better meet the challenging and changing environments predicted for the future.

Given the predicted changes in temperature and rainfall patterns for South Western Australia, identifying heat and drought tolerance during the early developmental stages in a plant's life cycle is vital for conserving species *in situ* and for effective restoration in a warming, drying world. Sampling seeds for *ex situ* collections should target populations across a species' range, in particular prioritising populations that appear most affected by climatic change.

Where species are considered vulnerable to a warming, drying climate, the focus should be clearly on monitoring populations across species' ranges to detect early signs of change, in particular in the post-fire environment.

References

- Cochrane A., Hoyle G.L., Yates C.J., Wood J. and Nicotra A.B. (2014a). Predicting the impact of increasing temperatures on seed germination among populations of Western Australian *Banksia* (Proteaceae). *Seed Science Research* 24: 195-205.
- Cochrane A., Hoyle G.L., Yates C.J., Wood J. and Nicotra A.B. (2014b). Drought stress impacts seed germination in four *Banksia* (Proteaceae) species from Western Australia: evidence from a controlled environment investigation using polyethylene glycol. *Australian Journal of Botany* 62: 481-489, doi: 10.1071/BT14132.
- Cochrane A., Hoyle G.L., Yates C.J., Wood J. and Nicotra A.B. (2014c). Climate warming delays and decreases seedling emergence in a Mediterranean ecosystem. *Oikos* doi: 10.1111/oik.01359.
- Cochrane A., Hoyle G.L., Yates C.J., Wood J. and Nicotra A.B. (2014d). The phenotypic response of co-occurring *Banksia* species to warming and drying. *Plant Ecology* doi: 10.1007/s11258-014-0414-z.
- Nemani R.R., Keeling C.D., Hashimoto H., Jolly W.M., Piper S.C., Tucker C.J., Myneni R.B., and Running, S.W. (2003). Climate-driven increases in global terrestrial net primary production from 1982 to 1999. *Science* 300: 1560-1562.
- Walck, J.L., Hidayati, S.N., Dixon, K.W., Thompson, K. and Poschod, P. (2011). Climate change and plant regeneration from seed. *Global Change Biology* 17: 2145-2161.

Teaming with volunteers to save our rare flora

Bob Dixon

Manager Biodiversity and Extensions, Botanic Gardens and Parks Authority, Kings Park, WA. Email: bob.dixon@bgpa.wa.gov.au

Under resourced? There is always a way around it!

Professionals responsible for rare flora translocations are generally under-resourced financially, time poor and short of people power. Without the help of volunteers, many rare flora translocations would simply not get off the ground. Volunteer assistance allows poorly funded projects – many in the past have only been funded for one year – to proceed and often continue for many years without adequate funding for human resources. There is no point translocating rare flora and walking away from the project after one or two years as it would undoubtedly be unsustainable; for example too much competition from weeds, and a lack of seed in the soil seedbank or on the plants to sustain future viable populations of the rare species. Also there would not be sufficient useful data on the biology and cultural requirements of the species,

and a paucity of monitoring data which is useless for scientific purposes.

I am not encouraging you to do rare flora translocations on the cheap, what I am saying is take on the translocation, when necessary, with voluntary help. It is better to save a species rather than say it is in the too hard basket and let the species become extinct in its natural habitat. Volunteers have the passion, time, commitment and many of the skills required so why not skill up a range of willing volunteers? At the Botanic Gardens and Parks Authority, Kings Park, we have done just that. I manage the Kings Park Volunteer Master Gardeners, a group of dedicated volunteers who are provided with comprehensive and specialist training to undertake translocation projects as required under Botanic Gardens and Parks Authority research and conservation programs.



Inspecting the critically endangered Corrigin Grevillea (Grevillea scapigera) at Hartleys site; one of three translocation sites for this species. Photo: Bob Dixon.

A longer-term view of unskilled labour

One could argue that using 'unskilled' voluntary labour is not appropriate for technical conservation projects, such as translocation of rare flora. My answer to this would simply be 'train them'!

The skills volunteers bring to projects can often be underestimated; many of our volunteers have skills I don't possess and I am only too pleased to welcome them on board. My volunteers come from a wide variety of professions, including medicine, marine science, information technology, education (principals and teachers), administration, linguistics and geology. Accordingly, the available skills in my team include horticulture, gardening, botany, statistics, computer programming, data entry and analysis, GPS use, and project management. To round it off, volunteers demonstrate total commitment to the projects because they are an integral part of them, having been involved in project design and planning. In my experience, the longer you maintain a volunteer group, the easier it is to manage them; once developed, the group tends to maintain corporate knowledge and specific project skills, and will even train new volunteers!

Kings Park Volunteer Master Gardeners group proficiencies

The following list notes the common skills and proficiencies with which our team of Volunteer Master Gardeners are equipped:

- transplanting seedlings (pricking out into pots);
- organising people to do tasks at Kings Park;
- coordinating field trips e.g. ensuring participants have appropriate training, and managing practicalities of getting there (including pick-ups as early as 5:00 am!);
- working knowledge of Kings Park plant identification system (punching identification codes onto aluminium labels and labelling plants);
- planting techniques;
- rotary hoeing rip lines;
- hand weeding (volunteers do not use herbicides on site) and site cleanup (cans, glass etc);
- seed collection (attaching seed sleeves to plants with developing seed, to hold them on the plant after they mature, ready for seed collection during the next site visit);
- seed cleaning and x-ray viability testing;
- vegetation surveys;
- site surveys (GPS and recording sites on ariel photographs);
- plant demography (recording survival, height and width, flowering, seed set etc; some projects require recording of demographic data for over 3000 plants); and
- data entry, statistics and graphical analysis for reports, publications/PowerPoint presentations.



Beenup old sand mine site (four rare ironstone species), back for the final monitoring in 2012, all species growing well and producing new recruits. What a great feeling going back and to see how well the site has progressed. Photo: Bob Dixon.

Generally we have more volunteers than places available for field trips so field berths are shared over time. Other volunteers are more than happy to do administrative or lab-based tasks which are also critical to the success of the projects. While we do not specifically ask the age of the Volunteer Master Gardeners in their application forms, we understand that many are in their 60s and 70s as well as some dedicated octogenarians. We always make sure they are happy with and capable of doing their tasks (particularly physical work), and break up tasks by rotation to make sure no one is over-exerted. That said, it would appear that many of the volunteers are fitter than people in much younger age brackets!

How do you keep volunteers happy?

It is very important to ensure each volunteer is an integral part of the group; I take care to greet them and answer questions as they arise. Every week, when possible, it's my pleasure to attend a morning tea where everyone brings in a plate to share. The idea is to socialise and talk about



August 2014, many hands make light work planting Sticky Eremophila (*Eremophila resinosa*) on site 6 at Westonia. Photo: Bob Dixon.

work (just half an hour of very valuable time). I make sure I keep volunteers informed of what the projects are about and how they can help. Their ideas and suggestions are taken on board, if there is an easier way of doing things, as long as the outcomes are the same, I want to know about it. As a group, over time, they sort themselves out. There are always people who like to be the president or on committees and just love organising things. They often look upon me as their mentor, welcome me as part of their team, but I ensure they are independent and make their own decisions by managing the group themselves. New training courses are organised and managed by a committee and changes to the courses are on-going, for example learning new technologies. The only part I play in these courses are giving talks and checking questions for the final exams.

What do the volunteers get in return? Volunteers have described a great deal of satisfaction in being involved in something they are passionate about; keeping active and using their brains (good for their health and wellbeing); and importantly, forming social connections which travel outside of the park. Since many volunteers have similar interests, a number of long lasting friendships (15 years and counting) have resulted.

Acknowledgements

I would like to thank Kings Park Volunteer Master Gardeners; BHP Billiton for funding the Beenup Project; Commonwealth and Western Australia governments for funding the Corrigin Grevillea (*Grevillea scapigera*) project and assistance from the Corrigin Shire and WA Department of Parks and Wildlife (Narrogin office); and Evolution Mining for funding the Sticky Eremophila (*Eremophila resinosa*) project.



Rewarding volunteers for finishing their work early, great incentive. Having lunch at Sandford Rock near Westonia before going on a bush walk. Photo: Bob Dixon.

Alpine restoration: identifying needs and determining priorities

Roger Good^{1*}, Stuart Johnston², Adrienne Nicotra³ and Jennie Whinam⁴

¹ Fenner School of Environment, Australian National University; ² Energy Networks Association, Kingston, ACT; ³ Research School of Biology, Australian National University; ⁴ Tasmanian Department of Primary Industries, Parks, Water and Environment.

*Corresponding author email: rgo03227@bigpond.net.au

Abstract

Alpine plant communities are very sensitive to disturbance, being at the edge of their ecological range, geographically localised, and consisting of species that are poor reproducers due to their specific phenology and relatively low seed production (often with low viability). Recent

research into plant ecology and restoration techniques in the alpine areas of the mainland and in Tasmania, together with the application of prioritisation frameworks such as the 'state and transition' model, now provide for effective restoration planning, the identification of priority sites for restoration and appropriate restoration techniques for individual sites.

Setting priorities for alpine restoration: criteria for restoration

Following the widespread 2003 wildfires that burnt over the mainland Alps, large areas of alpine herbfield and many peat bog and fen areas required restoration works. While a large amount of money was committed to the post-fire restoration program, these funds were insufficient to implement restoration works in all damaged sites, which were widespread, isolated and occupied varied terrain and topographic sites. To determine priority sites for restoration, criteria addressing ecological, educational, societal and financial demands and constraints were developed. The criteria for the peat bog and fen communities are set out below – most also apply to herbfield sites prioritisation as well.

- *Past history of damage*: extent of damage from prior grazing and/or fire.
- *Extent of degradation*: including (a) the extent of vegetation lost during the fires, (b) if peat incision had begun, and (c) if the peat/organic soils had become hydrophobic following the fires.
- *Size and extent of the communities*.
- *Significance of each site in terms of catchment value*: contribution of the community/ecosystem to catchment values and function.
- *Location*: both within the landscape and the catchment. Valley bottom bogs especially targeted due to their deeper peat beds and upper catchment mires targeted to retain water high in the catchment.
- *Accessibility*.
- *Recoverability*: some potential for recovery evident. *Sphagnum*, *Empodisma* and *Carex* species present and the peat beds still intact.
- *Long term monitoring potential and need*: location and significance.
- *Educational value*: bogs that could be used to illustrate management issues, functional processes, demonstrate restoration techniques and as interpretation sites.
- *Cost and benefit of restoration*: emphasising catchment protection and community values.
- *Iconic importance*: some areas have significant iconic importance (e.g. Pengilleys Bog in Kosciuszko National Park had a large Corroboree frog population prior to the fires and retained the potential for reintroduction of *ex situ* bred populations).

Setting priorities for alpine restoration: conceptual frameworks

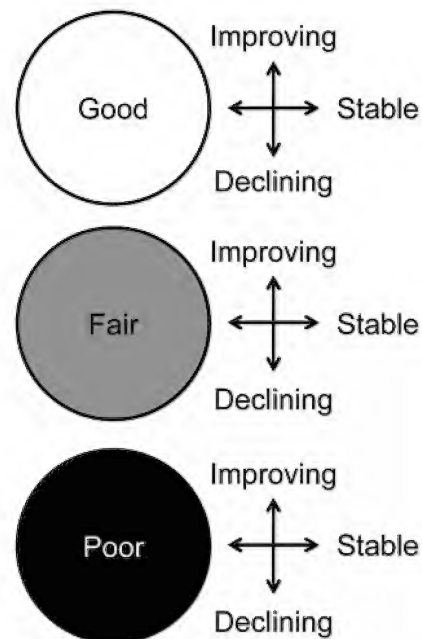
While the criteria set out above formed the baseline for prioritisation of sites for restoration, three conceptual frameworks (models) were also trialed to provide a more conceptually rigorous approach to site priority setting. The models, which depend on identification of the extent of degradation and trend in recovery or decline,

have previously been used in other montane and alpine ecosystem restoration programs:

- Traffic light model;
- State and transition model; and
- Research based scientific assessment framework

Traffic light model

The traffic light model requires expert opinion regarding the condition of the vegetation/ecosystem and the trend/direction of the condition (i.e. declining, improving or stable, even if in a disturbed state).



Traffic light model of plant community condition.

The traffic light model was used to classify 235 sub-catchments of the Australian Alps National Parks, where it was found that only 89 sub-catchments were in a good condition, 126 in moderate condition and 20 in poor condition. In terms of sub-catchment status, only 55 were deemed to be improving, 42 declining and 138 exhibited no change (stable), albeit many were in a disturbed or damaged condition as a result of past management e.g. cattle grazing (Worboys and Good 2011).

State and transition model

The state and transition model enables an understanding of the successional dynamics of alpine communities, particularly the alpine herbfields and groundwater communities (bogs and fens), where it has predominately been applied in restoration planning. The dynamics of any alpine ecosystem can be described as a set of discrete states with a set of transitions between them. The change from one state to another can involve a number of external

events or a single event depending on the change, duration and effects on the interactive controls, leading to a series of transition states.

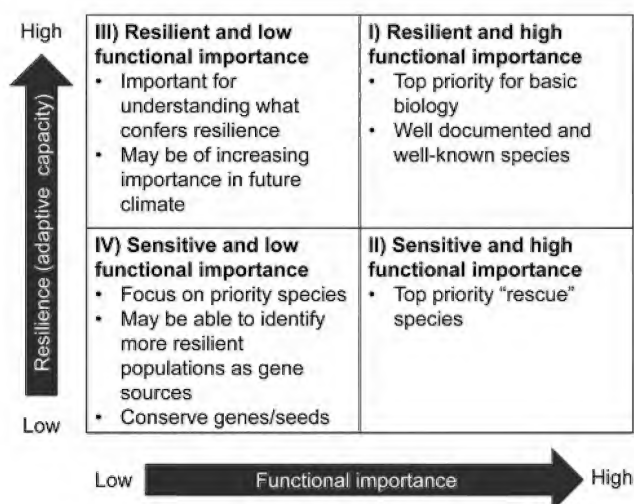
The state and transition model requires ecological information such as vegetation type and status; growth constraints (soil fertility, temperature and moisture regimes, occurrence of vesicular arbuscular mycorrhiza, etc), plant species germination traits, seedling establishment potential, and rate and extent of soil loss.

The state and transition model also contributes to recognition of probable constraints to the success of a restoration project and prompts the avoidance of techniques that may actually have a detrimental impact on post-restoration recovery (e.g. heavy mulching rates, high fertiliser application rates and the use of galvanised wire netting in alpine area restoration).

Research based scientific assessment framework

The 'framework' is a science-based system for ranking alpine plant species based on their functional importance and environmental significance within a vegetation community or ecosystem (Nicotra et al. 2014).

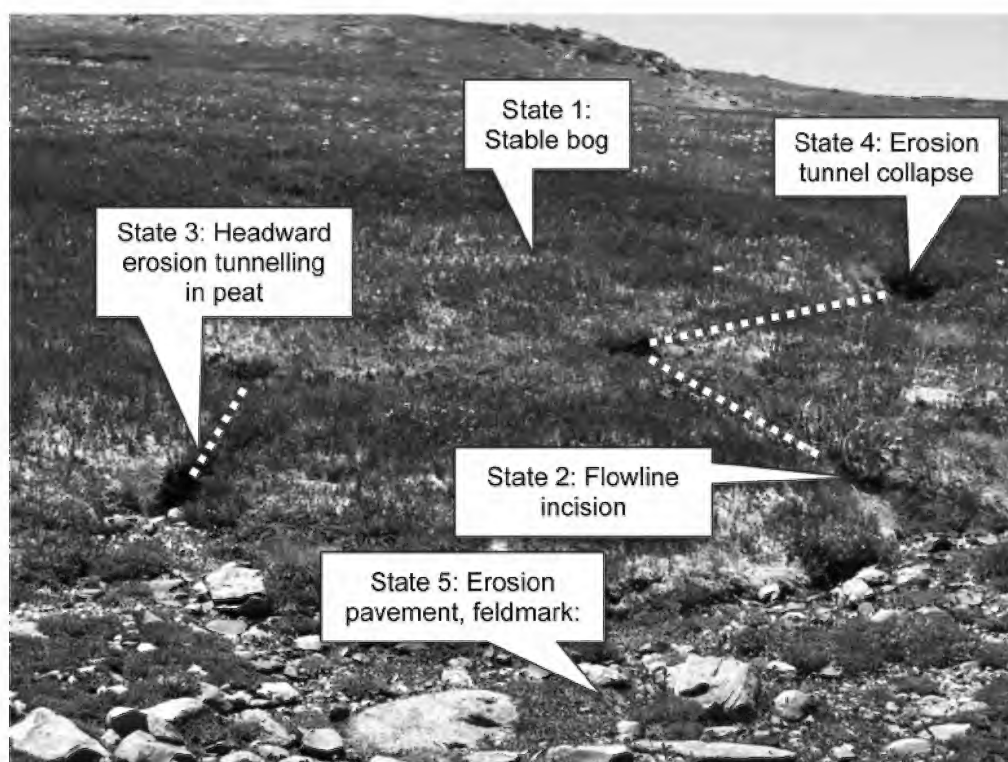
Knowledge of seed biology and germination traits has long been identified as a primary requirement for effective restoration of native alpine plant communities. The seed biology project has focused on the assessment of seed germination rates, dormancy patterns of alpine seeds, the role of maternal environments in seed traits and variation in quality, longevity and viability of seed stored for restoration programs.



Framework for setting restoration and management priorities (Nicotra et al. 2014).

In this framework diagram, the horizontal axis represents the functional contribution of the species to the ecosystem. High scoring species would include those having high functional importance, including keystone species, highly abundant species, or species making significant contributions to ecosystem function, such as *Sphagnum* moss. The vertical axis represents the resilience (or adaptive capacity) of a species. Low scoring species include those showing declines in abundance, slow growth, or increased sensitivity to external environmental factors. These would include species with narrow environmental limits or limited genetic variation.

Identification of states present in an alpine herbfield, for application of the state and transition management model.



Quadrant I species are both functionally important and resilient to fire and grazing impacts. These are the ‘bread and butter’ species for restoration works. Quadrant II species are of high functional importance but sensitive to impacts (e.g. climate change, grazing, fire). Quadrant III species are highly resilient but play a minor functional role in the ecosystem. Quadrant IV species have low resilience and play a minor functional role in the community – these may be rare species or species at the edge of their ecological range or distribution, and may be least likely to persist in future alpine communities, hence are less suitable for use in restoration programs.

Summary

Various models to assist in prioritising restoration activities are now available and have been utilised in our restoration programs over the past decade to assist in determining priority sites for restoration. These approaches are complemented and supported by the alpine seed ecology and germination research project (Nicotra et al. 2014) which developed a restoration prioritisation framework

based on seed and seedling traits. This work enabled the identification of priority areas for restoration as well as of a suite of species most appropriate for alpine restoration works in Australia.

References

- Nicotra, A., Hoffman, A., Morgan, J. and Miller, A. (2014). Towards a collaborative approach to adaptive ecological restoration and management in the Australian Alps. *Australian alpine research, conservation and management. Report of a symposium on Australian alpine plant research, conservation and management*. Available from: <http://tinyurl.com/lw34ohy>
- Johnston, S.W. (2007). *Function and sustainability of Australian Alpine Ecosystems: Studies in the Tall Alpine Herbfield Community, Kosciuszko National Park*. PhD Thesis, Fenner School of Environment and Society, Australian National University, Canberra.
- Worboys, G.L. and Good, R.B. (2011). *Caring for our Australian Alps Catchments: Summary Report for Policy Makers*. Dept. of Climate Change and Energy Efficiency, Canberra.

Assessing the risk of gene flow from plantation to native eucalypts: A long-term partnership in biodiversity management

Matthew J. Larcombe¹, Tim Leaman², René E. Vaillancourt¹ and Brad M. Potts^{1*}

¹ School of Biological Sciences and National Centre for Future Forest Industries, University of Tasmania, Hobart, Australia;

² Forest Practices Authority, 30 Patrick St, Hobart, Tasmania 7001, Australia. *Corresponding author email: b.m.potts@utas.edu.au

The large-scale translocation of species for agricultural, forestry or fisheries purposes has created numerous environmental issues world-wide that require management for industry sustainability and certification purposes. One such issue is ‘exotic gene flow’, where translocated ‘industrial-species’ can alter the gene pool of indigenous species through hybridisation and introgression. This exotic gene flow could have flow on effects to dependent native communities, especially where foundation species such as forest trees are involved (Potts et al. 2003; Whitham et al. 2006).

Over the last 25 years there has been a rapid expansion of eucalypt plantations in Australia. The estate is now nearing one million hectares, is mainly in temperate regions, and is dominated by *Eucalyptus globulus* and *E. nitens* (subgenus *Symphyomyrtus*) which are mainly grown outside their natural range. While eucalypt species from the major subgenera do not hybridise, hybridisation within subgenera is often reported, including hybrids with these

plantation species. In the late 1990s, the rapid expansion of the plantation estate into areas where potentially cross-compatible native species were common raised concerns that exotic pollen-mediated gene flow may threaten the genetic integrity of native forests around plantations (Potts et al. 2003). There was clearly a need to implement long-term research projects to determine the likelihood of exotic gene flow, and inform risk assessments that facilitate the adaptive management of genetic risk from eucalypt plantations. In partnership with the forest industry, government land managers and the Tasmanian Forest Practices Authority, we have undertaken this research for 16 years and provided support for its application to management.

Our initial focus was in Tasmania where the dominant plantation species, *E. nitens*, has been introduced from mainland Australia and is grown extensively in the vicinity of native species from the same subgenus (*Symphyomyrtus*). There are 16 species that are possibly

able to hybridise with *E. nitens* in Tasmania, and we assessed a range of pre- and post-mating barriers to identify the genetic risk posed to these species. For example, detailed multi-year flowering surveys demonstrated that *E. nitens* has varying levels of flowering synchrony with the 16 native species, and that the four species with the highest overlap (50–58%) required closest monitoring (Barbour et al. 2006b). Additionally, like many species, pollen dispersal from *E. nitens* plantations was shown to be highly leptokurtic (tightly centred), with most pollen deposited within only 200 m of the plantation (Barbour et al. 2005b). Postmating barriers were also investigated, with artificial hybridisation experiments using *E. nitens* pollen showing that cross-compatibility varied greatly between the 16 species, ranging from zero (*E. urnigera*) to 31% (*E. brookeriana*) (Barbour et al. 2005a). Furthermore, the fitness of exotic hybrids in terms of germination success and survival were reduced in comparison to the native species (Barbour et al. 2006a).

These empirical studies (and others) in *E. nitens* were used to inform the development of a risk assessment framework, by the Tasmanian Forest Practices Authority (FPA), which is now operational (Roberts et al. 2009). The document is designed to be used by Forest Practices Offices during plantation planning and assessment. It provides a risk assessment framework that combines information on site characteristics, including conservation status of surrounding eucalypts, with species susceptibility metrics – based on the empirical research above – to identify plantations which pose a low, medium or high risk of exotic gene flow to surrounding eucalypts. Each risk category has associated planning and monitoring requirements ranging from ‘no formal planning or monitoring required’, through to ‘do not plant without consultation with FPA, substantial planning and management obligations may apply’.



Pollen from *E. globulus* (section *Maidenaria*) applied to the distantly related *E. conglobata* (section *Dumaria*). Seedlings were produced from this combination but they died at the cotyledon stage, more closely related species, especially those in section *Maidenaria*, produced viable hybrids.

Photo: M. Larcombe.

We have now expanded this research to *E. globulus* plantations on mainland Australia, where gene flow by both pollen and seed dispersal are being assessed. The *E. globulus* estate is more than twice as large as the *E. nitens* estate, and there are more than 450 species (from *Symphyomyrtus*) that could be compatible with *E. globulus*. We designed a phylogenetically targeted crossing program to clarify barriers to hybridisation within subgenus *Symphyomyrtus* (Griffin et al. 1988), to determine which groups of species were most at risk of gene flow from *E. globulus*. This study showed that there was a virtually complete barrier to hybridisation between *E. globulus* and 70% of subgenus *Symphyomyrtus* species (the most phylogenetically distant; Larcombe 2014). The most compatible species were the 15% of subgenus *Symphyomyrtus* species from the same taxonomic section as *E. globulus* (*Maidenaria*), highlighting the fact that closely related species within the pollen dispersal zone of a plantation will be at most risk (Barbour et al. 2008; Larcombe 2014).

After identifying *Maidenaria* species as the highest risk, we targeted one of these species in a detailed case study. *Eucalyptus ovata* (*Maidenaria*) is of conservation significance, a common plantation neighbour, and is known to hybridise naturally with *E. globulus* (Lopez et al. 2001). Through detailed analysis of open pollinated *E. ovata* seed collected around plantations, we found that small remnant patches and trees on the edges of patches were most at risk of hybridisation, but that pollen penetration into larger patches was very low (Larcombe et al. 2014). This means that in plantation landscapes, maximising the size of remnant forest patches will help maintain their genetic integrity. However, surveys for naturally establishing hybrids showed that even in high risk situations, establishment of exotic hybrids was extremely rare (< 1% of seedlings). When hybrids did establish, their survival was 78% lower than *E. ovata* seedlings. This demonstrates that significant barriers exist to exotic gene flow even in this ‘high-risk’ species (Larcombe et al. 2014).

Seed dispersal in eucalypts is much more restricted than pollen dispersal. However the above study showed that wild plantation seedlings (wildlings) were more common around the boundary of native forests than hybrids. In collaboration with a visiting researcher from Portugal, Professor Joaquim Sande Silva, we undertook a project surveying wildling establishment along 290 km of plantation edge across the Australian *E. globulus* estate. Establishment was relatively low (17 wildlings/km), and the vast majority of wildlings were within 10 m of plantation edge, meaning they are likely to be removed during harvesting (Larcombe et al. 2013). The risk of invasion from *E. globulus* plantations in Australia seems low, but continued monitoring is warranted. This was highlighted in a recent reciprocal project replicating the survey undertaken in Australia in the much older Portuguese *E. globulus* estate, where the level of wildling establishment was about 15 times higher than Australia.



Professor Joaquim Sande Silva, from the University of Coimbra, Portugal, surveying for wildlings establishing along the boundary of a Victorian *E. globulus* plantation.
Photo: M. Larcombe.

In summary, through collaboration with industry and government over the last 16 years we have been able to provide the empirical evidence to support genetic risk assessment and sustainable management for both *E. nitens* and *E. globulus* plantations. We have shown that the highest risk situations are where native species are closely related to the plantation species, in small fragmented populations and/or, they are of conservation significance. Options now exist to identify and manage genetic risk in these situations.

References

A full list of references is available for download from: <http://eprints.utas.edu.au/id/eprint/20039>

Larcombe, M.J. (2014). *Exotic gene flow from plantation to native eucalypts*. PhD Thesis, University of Tasmania, Hobart.

Gardens for Wildlife: promoting biodiversity conservation in urban areas

Iona Mitchell

Department of Primary Industries, Parks, Water and Environment, Hobart, Tas. Email: iona.mitchell@dpiw.tas.gov.au

In Tasmania, land conservation programs for private landowners commenced around 1998/1999. Programs consisted of voluntary binding covenants which go on land title and provide protection of the natural values in perpetuity, even with change of landowner. These included the Private Forest Reserve Program, Protected Areas on Private Land, Non-forest Vegetation Program and the Forest Conservation Fund. Currently in Tasmania there are 760 conservation covenants covering an area of 96 142 ha of private land. There is also Land for Wildlife which is voluntary but non-binding (nothing goes on land title). Land for Wildlife in Tasmania is for properties which are 2 ha or greater, with currently 880 properties registered covering 56 680 ha (146 of these also have conservation covenants).

But what about people who do not have acreage or those living in urban/sub-urban areas? Gardens for Wildlife was developed to fill that gap in nature conservation schemes. It was developed in recognition that there was a place for an urban nature conservation scheme as a means of achieving broad community engagement in support of biodiversity conservation on private land and to get people thinking beyond their own backyards. There have been few schemes directed at urban landowners, particularly those with limited space.

The Gardens for Wildlife scheme aims to support, encourage and recognise landholders who are providing wildlife-friendly gardens and environment-friendly sustainable practices. Gardens for Wildlife gives people who do not have acreage the opportunity to show their support for biodiversity conservation and environment-friendly sustainable practices. It also shows that biodiversity conservation is for everyone not just large landholders, national parks or reserves.

Enhancing biodiversity in urban environments can have a positive impact on the quality of life of urban dwellers, which increases environmental awareness and can in turn encourage greater preservation of biodiversity more broadly. The majority of Australians live in urban environments; so many people will form their ethic of care for our native wildlife, their concern for conservation of remnant vegetation and interest in restoring degraded habitats in the suburbs and outskirts of cities.

Members are recognised through display of an attractive Garden for Wildlife sign, which promotes the scheme, increases community awareness and encourages others to join. Collectively lots of individual gardens can make a difference in caring for our environment and individual gardens can be seen as stepping stones providing linkages across the landscape allowing wildlife to move more easily and safely.



Garden for Wildlife sign, for display by members in their gardens. Image: Tasmanian Department of Primary Industries, Parks, Water and Environment.

The overwhelming message for why people wished to register for the scheme is because people love to see wildlife in their garden, native birds in particular, but many welcome bandicoots, lizards, frogs, wallabies and yes, brush-tailed possums! Many have used native plant species to provide habitat and to attract wildlife to their gardens. Encouragingly, many people have found that growing native plant species has attracted a greater variety of wildlife, especially native birds, into their garden which they gain great enjoyment from seeing.

The Gardens for Wildlife scheme also focuses on environment-friendly sustainable practices, as what we do in our garden can affect other places beyond our boundaries. Watering the garden uses precious water resources. After watering, or rainfall, any chemicals used, such as pesticides or excess fertiliser, will run into stormwater drains and eventually end up in the local river or estuary. Planting native species can reduce the use of water and chemicals.

The scheme also encourages productive food gardening with wildlife to encourage sustainable living but also to increase awareness of the benefits of natural pest control by wildlife, such as native birds, frogs, lizards and pollination leading to better crop production and fruit set. Often people think of wildlife as the larger, more visible species, such as mammals, birds or frogs with few people thinking about invertebrate fauna. Invertebrates play an extremely important role in pollination, soil health, nutrient recycling and food sources for other wildlife.

Of course, larger animals rely on invertebrates in many ways for their survival.

Gardens for Wildlife operates on a shoestring and does not organise or run workshops, events or other activities which require human and financial resources beyond those available to the scheme. The scheme operates in partnership with aligned government and non-government organisations, including the Understorey Network Inc., Sustainable Living Tasmania Inc., Royal Tasmanian Botanical Garden, Birdlife Tasmania, Australian Plant Society Tasmania Branch Inc., Tasmanian Natural Resource Management Regions and Still Gardening. Gardens for Wildlife members may participate in events or activities that the partner organisations run.



*Silvereyes (*Zosterops lateralis*) in a bath. Bird baths in the garden provide a lot of enjoyment for people.
Photo: Stuart Smith.*

Recently the scheme celebrated the milestone of the 500th member. Within Tasmania, Gardens for Wildlife has steadily grown to cover 2640 ha with currently 516 members. Gardens for Wildlife has now spread outside Tasmania. Barung Landcare Association in Maleny, Queensland, has adopted the scheme through a signed Memorandum of Understanding with the Tasmanian Department of Primary Industries, Parks, Water and Environment. They have used the same artwork for their Gardens for Wildlife sign changing the scarlet robin to a familiar bird of their region, the red-backed fairy wren.

What's killing the trees? Is climate change the cause of Ribbon Gum (*Eucalyptus viminalis*) dieback in the Monaro region of NSW?

Catherine Ross

Greening Australia Capital Region, ACT. Email: cross@greeningaustralia.org.au

Introduction

Over the last decade, the health of eucalypts in the Monaro region has experienced a steady decline, in particular Ribbon Gum (*Eucalyptus viminalis*), the dominant species in the region. The widespread loss of this species has a significant effect on the local environment, and the problem is of increasing concern to local landholders and visitors to the region. During my honours year I investigated this issue, in order to determine the cause of the dieback and provide advice to Greening Australia on what could be done to rehabilitate the area.

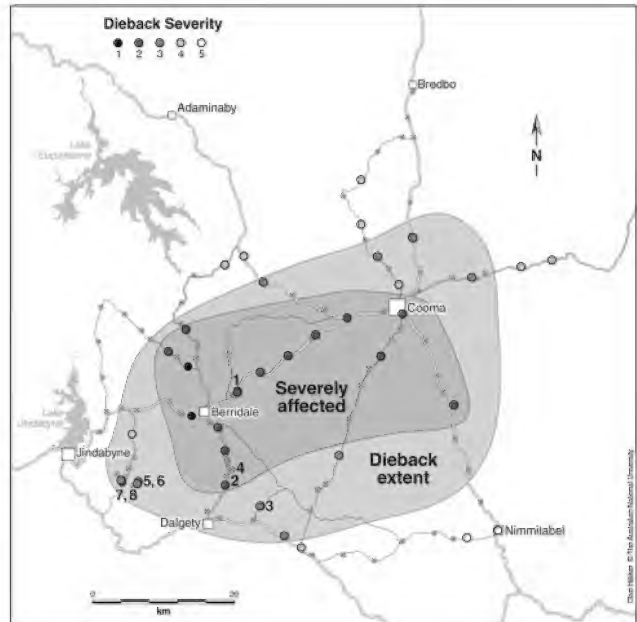


Ribbon Gum (*Eucalyptus viminalis*) dieback on Jindabyne Road between Cooma and Berridale.
Photo: Tim the Yowie Man.

The Monaro Dieback – extent, severity and symptoms

The Monaro is a high plain in southern NSW extending between Bredbo, Numeralla, Nimmitabel and Jindabyne. In 2012 I conducted a road survey of the area in order to map the extent and severity of the dieback, stopping at 5 km intervals to record tree health on a scale from 1 (severely affected) to 5 (very healthy) based on crown shape and density, foliar damage, dead branches and epicormic growth. The affected area is almost 2000 km², almost the size of the Australian Capital Territory. A central area within the region was severely affected, with most of the trees either dead or very close.

The dieback was very species specific, affecting only Ribbon Gum (*E. viminalis*) and to a lesser extent Candlebark (*E. rubida*). Ribbon Gum was the dominant species in



Map of Monaro region showing road survey sites (grey circles indicate no Ribbon Gum present, coloured circles indicating dieback severity), study sites (labelled 1–8), and dieback extent (outer shaded area) and severely affected area (inner shaded area). Map: Clive Hilliker.

most of the affected areas, and usually occurred on rocky outcrops and hills surrounded by grazing land. Other co-occurring species were relatively unaffected, including Apple Box (*E. bridgesiana*), Snow Gum (*E. pauciflora*) and Black Sallee (*E. stellulata*). The edges of the dieback seemed to be defined by a change in species composition, where Ribbon Gum was not the dominant species.

The Monaro dieback has been associated with the Eucalyptus Weevil (*Gonipterus* sp.). These small, brown beetles and their larvae have been observed in large numbers on affected trees, and all the remaining foliage shows characteristic damage. Ribbon Gum is one of the weevil's preferred hosts, and trees treated with stem-injected pesticides have shown a significant improvement in health (Neil Murdoch, University of Sydney, pers. comm. 2012). The Eucalyptus Weevil is native to eastern Australia, and has not been known to have severe outbreaks in its native range – so there must be an underlying cause of the outbreak.

Causes of dieback

Dieback is often caused by a range of interacting factors that make identifying the solution to the problem very difficult (Manion 1981). The three main theories put forward to explain insect related dieback are:

- agricultural practices;
- fire exclusion; and
- climate and extreme weather.

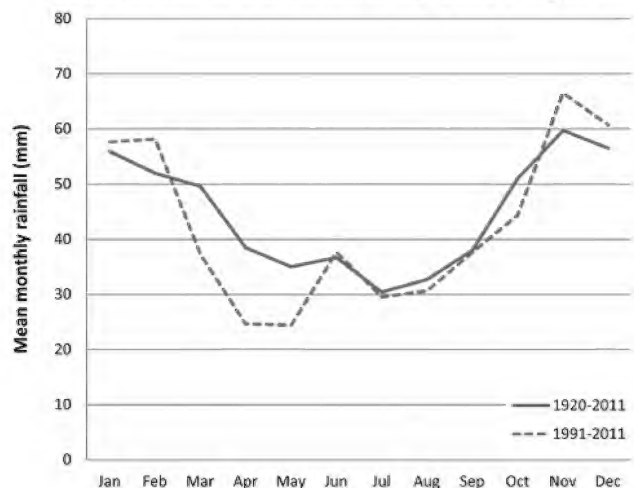
I investigated the potential for these theories to explain the Monaro dieback by comparing Ribbon Gum sites with different histories of agriculture and fire, and by analysing historical climate data (Ross 2013).

In Australia, several episodes of insect-related Eucalyptus dieback have been attributed to agricultural practices (Landsberg and Wylie 1988). The Monaro region has been partly cleared and grazed by sheep for well over a century, however there are also some areas such as travelling stock reserves which are relatively undisturbed which can be used for comparison. In a number of stock reserve and grazed paddock sites, I measured the severity of dieback as well as the Structural Complexity Index (McElhinny et al. 2006), which took account of a range of indicators including hollow-bearing trees, understorey density, and fallen logs which are related to biodiversity and resilience. Despite differences in land management and structural complexity, there was no difference in the severity of dieback between relatively undisturbed stock reserves and grazed paddocks, indicating that agricultural practices were not likely to be the main driver of tree decline in this case.

Fire exclusion, resulting in increased tree stress via changed soil conditions, nutrient imbalances and proliferation of woody shrubs, has also been suggested as a cause of dieback (Jurskis and Turner 2002). In 2003, a bushfire burnt several small pockets on the edges of the dieback affected area, providing an opportunity to observe the effects of burning. Despite significant differences in structural complexity between burnt and unburnt sites, there was no difference in the severity of the dieback.

Climate change and extreme weather have been implicated in an increasing number of dieback episodes around the world (Allen et al. 2010). The Monaro region has recently experienced one of the worst droughts on record, along with a change in rainfall distribution throughout the year (a significant reduction in autumn rainfall). These conditions are likely to cause tree stress and may lead to attack by insect herbivores. Ribbon Gums are normally found in areas with higher rainfall and the Monaro is at the edge of their climatic range, so the recent changes in climate may have pushed the species beyond a critical threshold.

Annual rainfall distribution in the Monaro region



Annual rainfall distribution in the Monaro Region: when compared to the long-term average from 1920-2011, the last two decades have experienced a change in rainfall distribution. Autumn rainfall has decreased, while late spring and summer rainfall has increased.

I concluded that the most likely explanation for the Monaro dieback is climate (specifically rainfall). However, much of the evidence is circumstantial, and it is still unclear how changes in climate and insect infestation are interacting to cause the dieback.

Implications and management

Given that there is no evidence of recovery and very little regeneration, it seems likely that Ribbon Gum will disappear from an area where it has been dominant. The loss of this important species will result in a fundamental change to the Monaro landscape. This may represent one of the first cases of significant vegetation change due to climate change in eastern Australia.

The challenge for managers over the next few years will be to decide not only how to restore this landscape, but also what our aims are given that the restoration of Ribbon Gums on the Monaro may no longer be possible. One possible method may be to introduce species that will be able to tolerate the predicted future climate, while also providing some of the ecosystem services and values that have been lost. This is a controversial suggestion, but one that requires serious consideration and discussion.

Acknowledgements

This article is based on research undertaken as part of an honours project titled *What's Killing the Trees – an investigation of Eucalypt dieback in the Monaro region, NSW* (Ross 2013). The project was completed at the Fenner School of Environment and Society at the Australian National University, with financial and advisory support from Greening Australia. Huge thanks go to my supervisor Cris Brack for his support and guidance, and to the staff at Greening Australia for their assistance and expertise.

References

- Allen, C. et al. (2010). A global overview of drought and heat-induced mortality reveals emerging climate change risk for forests. *Forest Ecology and Management*, Volume 259, pp. 660-684.
- Jurskis, V. and Turner, J. (2002). Eucalypt dieback in eastern Australia: a simple model. *Australian Forestry*, 65(2), pp. 87-98.
- Landsberg, J. and Wylie, F. (1988). Dieback of rural trees in Australia. *GeoJournal*, 17(2), pp.231-237.
- McElhinny, C., Gibbons, P. and Brack, C. (2006). An objective and quantitative methodology for constructing an index of stand structural complexity. *Forest Ecology and Management*, Volume 235, pp. 54-71.
- Manion, P. (1981). *Tree Disease Concepts*. Englewood Cliffs, New Jersey: Prentice-Hall Inc.
- Ross, C. (2013). What's killing the trees? An investigation of Eucalypt dieback in the Monaro region, NSW. Honours thesis, ANU Fenner School of Environment and Society.

Azorella macquariensis: battling for survival in the subantarctic

Natalie Tapson

Royal Tasmanian Botanical Gardens, Hobart, Tasmania. Email: Natalie.Tapson@rtbg.tas.gov.au

Macquarie Cushion (*Azorella macquariensis*) is endemic to Macquarie Island and has been listed at the highest level of threat both federally and at the state level since 2010. Macquarie Island lies at 55°S, approximately 1500 km SSE of Tasmania, and is administered by the Tasmanian Parks and Wildlife Service (TASPWS). It was listed as a World Heritage Area in 1997, mainly for its geological values, being the only island on earth that is composed of oceanic crust and rocks from deep within the mantle. Tectonic plate movement forced the island up above the sea about 600 000 years ago. There are 46 vascular plant species on Macquarie Island, four of which are endemic.

Macquarie Cushion is the major structural component of the island's feldmark vegetation which occurs on the plateau and makes up 45% of Macquarie Island's vegetation. The plateau is just 200 m to 400 m above sea level but because Macquarie Island is so far south and buffeted by ferocious winds, it is an extreme windswept environment that experiences cycles of freezing and thawing. Dieback in Macquarie Cushion was noted in the north of the island in late 2008 after the plant came out of winter senescence and by 2011 the dieback was widespread across the island.

The Royal Tasmanian Botanical Gardens (RTBG) has been involved in the collaborative response to the dieback since 2009 together with the Biodiversity Conservation Branch, Tasmanian Parks and Wildlife Service, Australian Antarctic Division, University of Tasmania and Australian National University. Research to date has looked at:

- the physiological susceptibility of Macquarie cushion to environmental stress;
 - germination and vegetative propagation requirements; and
 - the establishment of an *ex situ* seed orchard on Macquarie Island.
- The RTBG have been directly involved in the last two points and although a pathogen has not definitively been shown to cause the dieback, the fungus *Rosellinia* has been found to be strongly associated with the soil of dieback-affected plants. Research into susceptibility to environmental stress has shown that Macquarie Cushion has a rudimentary vascular system and responds poorly to drought. A review of climate data from 1992 to 2008 showed that there was a deficit in the amount of water available to plants for over 50% of the growing season. It seems likely that the cause of the dieback is multi-factorial.
- Plants and tissue culture material were collected by the RTBG from the Island in 2009 but there was limited success with the tissue culture propagation and the plants proved difficult to maintain in cultivation so it was decided to establish a trial seed orchard on the island in 2010. A site on Wireless Hill near the Australian Antarctic Division (AAD) base on the isthmus was selected for a number of reasons. Major considerations were the close proximity to the base for monitoring and maintenance and the availability of the communications shed to collect water for irrigation. RTBG Nursery Supervisor Michelle Lang travelled to Macquarie Island during resupply in April 2010 and installed the infrastructure to house nine plants that were collected from the Overland Track that runs along the plateau from the north to the south of the island.
- monitoring the progress of the dieback and its long term impact on the structure of the feldmark vegetation;
 - pathogen involvement;



Azorella macquariensis seed orchard plants 46 to 54, November 2014. Photo: Chris Howard.

The original nine plants flourished and grew and flowered at a much greater rate than was expected and in 2011 Curator of Subantarctic Collections Lorraine Perrins applied for grant funding to increase the orchard to at least 50 genotypes to capture the genetic variability of the species on the island. She was successful in receiving \$12 000 from the Mohamed bin Zayed Species Conservation Fund in 2011 and the \$11 000 from the Foundation for National Parks and Wildlife in 2012 as well as \$4000 in public donations. The project received a berth on the island in the AAD summer program for seven weeks between October and December 2013 and I was lucky enough to travel to Macquarie Island and have the opportunity to build up the seed orchard from the original nine to 54 genotypes.

The submission to the AAD for a berth for the project had been for four months over the full summer period but at the time space on the island was at a premium due to the Macquarie Island Pest Eradication Project (MIPEP) that was tasked to remove rabbits and rodents from the island. This meant that the originally planned timeline of 12 weeks was compressed into seven, but the upside was that the MIPEP team were covering every inch of the island monitoring for pests and they generously provided support to the RTBG project, collecting over half of the 45 new plants.

The materials to build the orchard had been dropped on Wireless Hill by helicopter in March 2013 so my first task was to put the pots in place, prepare and fill them with mix and install the irrigation. The tubes were 800 mm high to accommodate the long tap root of the Macquarie Cushion and each was filled with approximately 20 L of a mix of 3 peat:2.5 perlite:2 gravel. The conditions on Wireless Hill can be extreme with wind often above 30 knots (56 km/h), making the simple task of shovelling the mix into the pots challenging but this is part of the joy of working in such a wild place.



Completed *Azorella macquariensis* seed orchard on Wireless Hill, December 2013. Photo: Chris Howard.

Once I had completed field training, I was able to go out into the field and start collecting plants. Small solitary plants were collected from as many representative habitats from sheltered east facing slopes to exposed plateau. In the time available I was able to cover two thirds of the island. Over half the new plants were collected by the MIPEP team and TASPWS ranger in charge, Chris Howard but the success of the project was truly a team effort with help from expeditioners carting materials up Wireless Hill, acting as collecting buddies with me in the field and AAD staff with infrastructure for the irrigation. The plants continue to be photo-monitored by the ranger in charge and only one plant of the 45 had been lost when they were monitored in November 2014. Chris Howard will use this plant's GPS collection location to replace it with another plant from the same area.

The original nine plants were flowering well in the November 2014 monitoring and the first seed will be collected at the end of summer 2015. Work continues by RTBG Seedbank Coordinator, James Wood, to elucidate the germination requirements and seed from the orchard will help to build up a viable *ex situ* conservation collection in the Tasmanian Seed Conservation Centre at the Gardens.



Azorella macquariensis #9 planted in April 2010 with flower buds in November 2014. Photo: Chris Howard.

Moving from monoculture to multiculture: a history of Bitou Bush on the Tweed Coast, northern NSW

Rhonda James¹, Tanya Fountain² and John Turnbull³*

¹ Principal, Bushland Restoration Services; ² Biodiversity Officer, Tweed Shire Council; ³ Bushland Officer, Tweed Shire Council, Murwillumbah, NSW. *Corresponding author email: jturnbull@tweed.nsw.gov.au

Background

Bitou Bush (*Chrysanthemoides monilifera* subsp. *rotundata*) was utilised by the Soil Conservation Service of NSW and mining companies from 1946 until 1968 to stabilise and rehabilitate frontal dunes and inland Holocene sands following mining of minerals along much of the 37 km coastline of Tweed Shire Local Government Area (LGA).



Fingal Peninsula Bitou Bush planting site adjacent littoral rainforest remnant c1962. Photo: Robert L. Anthony, Tweed River Regional Museum Collection.

In 1981–1982, state-wide coastal Bitou Bush surveys undertaken by helicopter found that Bitou Bush:

- was present in 80–85% of NSW north coast coastline; and
- was “very common” along 35% of the NSW north coast coastline.

NSW National Parks and Wildlife Service (NSW NPWS) mapping in 2001 found that 97% (929 ha) of Tweed Shire’s coastal zone (primarily council managed crown land) was occupied by Bitou Bush at very heavy to low densities. Bitou Bush had also invaded intact bushland remnants which had not been mined.

By July 2014 however, Bitou Bush occurs in low densities in only 10% of the Tweed Coast coastal zone. In this article, we describe the measures that have been undertaken to achieve such a reduction in this Weed of National Significance.

Impacts on biodiversity values

The Tweed Coast has been identified as an area of high biodiversity. Kingston et al. (2004) assessed that 408 ha of high to very high and 456 ha of medium ecological status vegetation occurred within the 2 km wide coastal zone. In particular, coastal vegetation communities, including littoral rainforest, *Banksia* woodlands, grassy headlands, heathlands and coastal wetlands, were identified as disproportionately cleared and/or poorly reserved.

The dense habit and highly invasive nature of Bitou Bush enables domination and replacement of native species. Bitou Bush restricts recruitment and regeneration of native flora and can reduce the diversity of native birds, mammals and ground-dwelling insects. It provides shelter for pest animals including rabbits and hares which browse native vegetation and foxes which eat and disperse the seeds and prey upon native fauna.

A history of Bitou Bush management on the Tweed Coast

Key policy and management milestones for the control of Bitou Bush on the Tweed Coast include:

- 1998: Bitou Bush declared as Noxious in NSW;
- 1999: Declared a Weed of National Significance, and scheduled as a *Key Threatening Process* under the NSW Threatened Species Conservation Act 1995 (TSC Act).
- 2003: Tweed Shire commission *Tweed Shire Bitou Bush Control Strategy* (James and Wilson 2003).
- 2006: NSW NPWS finalise *Invasion of native plant communities by Chrysanthemoides monilifera* Threat Abatement Plan. Management in line with the plan attracts regular funding.
- 2009: Bitou Bush National Northern Containment Zone (NNCZ) Management Plan, focused on the Fingal Peninsula.
- 2011: Bitou Bush NNCZ Management Plan Stage Two expanded control actions to the southern boundary of Tweed Shire.
- 2014: Following lobbying from Far North Coast Weeds (FNCW) and the Tweed Coast Vegetation Management Committee, Bitou Bush was reclassified as a Class 3 noxious weed in Tweed LGA under NSW legislation. Under this categorisation, private landholders are required to suppress and destroy Bitou Bush.

Funding

Funding obtained for Bitou Bush and other weed control in the Tweed coastal zone between 2002 and 2014 came from a range of funding sources including:

- Commonwealth Government (National Heritage Trust, Biodiversity Fund);
- NSW Government (Environmental Trust, NSW NPWS, Department of Primary Industries, NSW Agriculture, Crown Lands, FNCW and the Northern Rivers Catchment Management Authority); and
- Tweed Shire Council.

Total funding for restoration works from 2002–2014 was \$1 597 500, with \$592 500 allocated specifically to Bitou Bush control. Of this funding, Tweed Shire Council contributed \$570 000 in cash and labour. The efforts of six Dunecare groups who provide an estimated 3000 or more hours each year of unpaid effort were not factored into these figures.

Control activities

Bitou Bush is controlled by low dosage applications of the herbicides glyphosate (2 L/ha or 1:200) or metsulfuron methyl in winter months when native vegetation is not actively growing. A range of control methods have been utilised including:

- Aerial spraying of broad scale infestations from 2002–2005 and again in 2007.
- Hand control by backpack sprayer, cut, scrape and paint and in some cases power-spraying was utilised, steep sites also required abseiling to access infestations.



Bitou Bush (Chrysanthemoides monilifera subsp. rotundata) in flower. Photo: John Turnbull.



Abseiling to control Bitou Bush, Norries Headland, Tweed Shire. Photo: Austspray

- Occasional mechanical control (slasher or mulcher head).
- Biological control, several agents were released along the coast including Leafroller Moth (*Tortrix* sp.), Bitou Seed Fly (*Mesoclanis polana*) and Bitou Tip Moth (*Comostolopsis germana*). Due to adverse weather conditions, bushfire events and accidental spraying at release sites, these agents had limited impact and failed to establish.
- Burning which promoted mass germination from Bitou Bush soil seed stock – seedlings were subsequently controlled by herbicide spray.

In addition to these control activities, Tweed Council and Far North Coast Weeds regularly monitor and map Bitou Bush density and coverage to inform the control effort; ground surveys and aerial photograph interpretation were undertaken in 2003 and 2007–2008 and aerial surveys have been undertaken annually since 2010.

Recovery of flora and fauna

Bitou Bush occurrence has now been reduced to low densities, only affecting around 10% of the Tweed coastal zone. Areas once dominated by dense Bitou Bush now support a diversity of species, and littoral rainforest has expanded into gaps and colonised adjoining areas previously supporting Bitou Bush. Over a ten year period, 49 naturally recruited native plant species have been recorded at one 30 ha rehabilitated site (at Casuarina), with natural recruitment observed at numerous other sites including littoral rainforest at Hastings Point, Fingal Head and Wooyung. In particular, the endangered (NSW TSC Act) Pink Nodding Orchid (*Geodorum densiflorum*) has increased in abundance; in 2002 only one population was recorded for the Tweed coast (< 10 populations in NSW), however six populations now occur in the Tweed coastal zone with another three in adjacent soil-based vegetation communities.

Limited data are available to assess increases in native fauna diversity aligned to Bitou Bush control and native vegetation recovery, however available information suggests that Bitou Bush control measures are having a positive impact on fauna – particularly birds – in the region. Birdlife Northern Rivers have undertaken monthly surveys since January 2005 in the Fingal Head littoral rainforest remnant when 60 species were recorded. In November 2014, 104 species were recorded. At Fingal Peninsula, 28 species were recorded by Birdlife Northern Rivers in the 1960s, with 133 species recorded in 2014. Opportunistic sighting by Dunecare members at Hastings Point (2009–118 species; 2014–173 species) and Casuarina Beach (126 species over 8 years) suggest increasing bird diversity over time.

Conclusion

Tweed Council's aim is to reduce the distribution, abundance and impacts of Bitou Bush in and on the ecosystems of the Tweed Coast. Future Bitou Bush control activities in the Tweed LGA will include:

- ongoing control of Bitou Bush and successional weeds and supplementary plantings of native species;

- continued commitment by land managers to fund control on their land;
- external funding sought by land managers for Bitou Bush control through external funding programs with support from government bodies;
- support for local noxious weed authority liaison with private landholders and the community to ensure awareness/compliance with statutory weed control obligations; and
- continued Council support for 'Care' and community groups engaged in land management.

References

- Kingston, M.B., Turnbull, J.W. and Hall, P.W. (2004). *Tweed Vegetation Management Strategy 2004*. Report prepared by Ecograph for Tweed Shire Council, August 2004.
- James, R. and Wilson, C. (2003). *Tweed Shire Bitou Bush Control Strategy*. Report prepared by the Dune Care Advisory Committee for Tweed Shire Council, April 2003.

Considerations for large-scale biodiversity reforestation plantings. Part 2: the planning framework

Dan Cole¹ and Greg Siepen²

¹ The Water and Carbon Group, Brisbane, Qld. Email: d.cole@waterandcarbon.com.au

² Ecological Consultant. Email: gregory.siepen1@gmail.com

Introduction

This article is the second in a series discussing considerations needed in large-scale tree planting for biodiversity outcomes. After securing the land on which to plant, it is imperative to undertake detailed planning to meet project goals. We discuss ecological planning considerations, along with site assessment and planting methodologies, including density selection and plant procurement.

Ecological planning: desk-top searches and field assessment

Desk-top searches and field-based assessments are both essential for reforestation planning. As part of the desk-top assessment, several online searches can be undertaken which may vary in each state and territory, but which will yield important information that can influence the

planting project. Generally, the following searches should be undertaken:

- Aboriginal and European cultural heritage sites and significance;
- contaminated lands (e.g. asbestos materials, unexploded ordnance);
- existing infrastructure (e.g. internal fences);
- existing uses (e.g. community leases, agistment contracts);
- vegetation mapping (remnant reference communities);
- flood levels, waterway maps, significant wetlands (e.g. Ramsar sites);
- topographic contours and specialised soils (e.g. acid sulphate soils);
- corridor mapping and iconic animal (e.g. Koala) management plans;

- registers of threatened native fauna and flora, weeds, pest animals and marine plants;
- biosecurity concerns (e.g. fire ants, myrtle rust); and
- other items such as fire management considerations and location in specialized management districts (e.g. coastal areas).

Ecological planning: field-based assessments

1. Evaluation of historical disturbance and risks to success

Preliminary site assessments need to consider historical land use. Some sites will have great potential for re-establishment of large-scale native forests. Other sites may be degraded by past agricultural activities such as grazing predisposing reforestation efforts to achieving lower rates of establishment or even complete failure. It is critical that potential risks are considered as part of the reforestation planning. Risks that should be evaluated on-site include potential for browsing and vandalism, along with seasonal and stochastic events that include drought, flooding and frost. Risk management and contingency planning will be discussed in a future edition.



*Site soil investigation and sampling during field assessment.
Photo: D. Cole.*

2. Linear infrastructure

All linear infrastructure must be identified in site assessments and be incorporated into the mapping, site design and works methodology. Location of easements for powerlines, water pipelines, fences, roads, and access tracks are important considerations to ensure functional site design that will assist implementation and maintenance activities. Access tracks are essential and can often be integrated as fire breaks. On some sites these structures may cover a significant area which can affect overall planting densities on the actual land available for planting.

Powerline easements are often not considered, but should be identified and mapped as potentially requiring a

different reforestation treatment such as a shrub corridor, or designated as an exclusion zone or access area.

3. Reference remnant vegetation

Identifying a reference system such as a remnant vegetation community (for example regional ecosystem in QLD) will inform the reforestation design. Regional ecosystems occurring on or adjacent to sites should be analysed to determine possible species mixes suitable for reforestation plantings depending on the occurrence of different geological formations and land-use systems.

For example, a eucalypt dominated forest with a significant shrub layer could still be remaining on the adjacent ridges, overlaying metamorphic rocks (for example shales and schists), but the planting site may be lower down the slope and could require a different range of eucalypts and possibly no shrub layer, or a shrub layer of species adapted to deeper, more fertile soils (for example riparian forest community with grasses and sedges). Hydrology and aspect also influence the selection of plant species. Delineating each management zone where a different forest type (regional ecosystem) is to be reinstated is essential to good planning and implementation.

Planting methodology

Compared to small patch restoration, large-scale reforestation requires detailed planting methodologies for the different land systems or zones occurring on each site. For example, large biodiversity plantings in community parks necessitate:

- a low density of plants per hectare to ensure amenity and for human safety;
- species that do not have projections (e.g. thorns) that can injure people and pets;
- location in blocks with deep mulch for ease of maintenance and prevention of weeds; and
- in more rural, cleared areas, densities can be greater and plants may be planted in rows for ease of weed control.

Site-specific mapping determines the land area for each management zone. Planting density may often vary between each zone and can be informed by the canopy structure of the reference system. For instance, when reinstating an open eucalypt forest community a target density is typically 1000 stems per hectare, whereas in riparian zones a higher density of 1500 plants per hectare is typical due to associated challenges that can include steep banks and increased weed pressure due to moist soils. There is also a more immediate need for vegetation cover to mitigate erosion risks due to potential flooding events.

The works methodology or technical specifications will often set out the deliverables between the client and contractor and include measurable targets. Density is one such measurable performance indicator where tree stocking rates and mortality can be audited.

Biological timescales: phased plantings

It can take decades for a reforestation project to exhibit qualities of a reference vegetation system. Phased planting, instead of planting all individual plants at the one time should be considered depending on funding and planting goals. For instance, Phase 1 treatment could consist of pioneer and primary canopy tree species that are proven to perform. Phase 2 planting could be an understorey enhancement introducing native shrubs, grasses, herbs and forbs along with difficult to establish species that will receive protection from the emerging Phase 1 canopy.

Site design

1. Planting rows on contours

The decision to plant in rows is often dictated by the scale of the project, the type of landscape and maintenance or weed control methods to be employed. Planting in rows allows access for water trucks, tractors, slashers and maintenance vehicles.

2. Infill and haphazard planting

Haphazard or random infill planting is often the preferred method for patch scale and riparian revegetation projects. Planting trees and shrubs in a haphazard design is often thought the ideal way of reproducing native forests. This method may be very difficult to implement efficiently on large-scale projects.

Seasonal timing

Seasonal timeframes and targeting favourable weather conditions (e.g. wet season) are critical aspects of the plan and very important to the success of the whole project. The overall reforestation plan should be flexible enough to allow for a reduction in planting if periods of extremely dry weather occur and an increase in planting if significant rain occurs.



Plant procurement: nurseries involved in large-scale projects need to plan production of large numbers of seedlings.

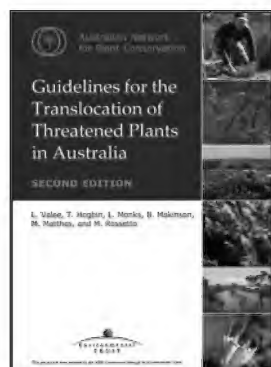
Photo: D. Cole.

Plant procurement

Plant procurement can take place once the species lists have been derived based on the learnings from the site, as well as assessments understanding the reference vegetation system's canopy architecture, floristics and species abundances. However, reforestation species lists are often shortened due to some species being very difficult to grow in nurseries or species are not grown in sufficient quantities due to poor seed production in certain years. Long lead-times for native plant production are required for large-scale reforestation.

Conclusion

Thorough planning is required to ensure a successful large-scale reforestation project, and involves both computer-based assessments and field-based assessments. Implementation of the 'grand plans' to meet project goals will be discussed in the next article in the series.



Guidelines for the Translocation of Threatened Plants in Australia

The deliberate transfer of plants or regenerative plant material from one place to another (eg re-introduction, introduction, re-stocking).

Second Edition 2004 | L. Vallee, T. Hogbin, L. Monks, B. Makinson, M. Matthes and M. Rossetto
Australian Network for Plant Conservation, Canberra.

For more information and to order, go to <http://www.anpc.asn.au/publications/translocation.html>

ANPC member profile

Roger Good

What are your current and past roles?

I worked as a Project Officer for the NSW National Parks and Wildlife Service before I retired from the Public Service. I own and manage a small environmental consulting company.

During my many years in the NSW Public Service I was fortunate to have been able to develop and undertake many ecological restoration projects, particularly in the Snowy Mountains. This work included the restoration of damaged peat bogs and fens, which lead to a major restoration program for these communities following the 2003 wildfires. I have been a participant in a sphagnum peat bog and fen research and management group for some 15 years and this research program is ongoing. Alpine sphagnum peat bogs are listed as an endangered ecological community.

From the late 1970s to the present time I have been a Director of the Murray Darling Wetlands Working Group which was established several years ago to work with rural landholders in the catchment to manage riverine wetlands. Approximately 80 000 hectares are now under collaborative management in the Murray region of the Basin.

What projects are you working on at the moment?

I have been an honorary research associate at the Australian National Botanic Gardens (ANBG) for four years where I work with a group of research and management personnel from both the ANBG and the Australian National University (ANU) studying the germination and establishment traits of alpine plants. This program has contributed much to our knowledge of threatened alpine species and our understanding of which alpine species are appropriate and suitable for ecological restoration projects.

As a Visiting Fellow at the ANU Fenner School for the past two years, I convene a steering committee overseeing a Sydney Sandstone Peat Swamp research program. This is a collaborative program between wetland/swamp research staff from ANU, University of NSW, Macquarie University, Sydney University and the Royal Botanic Gardens Sydney. An outcome of this program will be guidelines for the conservation and management of this endangered ecological community.



How did you end up working in plant conservation?

I developed a personal interest in native plants from a very early age while attending Yanco Agricultural High School in the Riverina, where I pursued studies in agriculture, horticulture and native plant ecology.

Following my secondary education, I gained a Public Service cadetship to Hawkesbury Agricultural College, and then to the University of New England and the University of NSW, where I had the opportunity to study

native plant ecology and restoration. I then joined the NSW Soil Conservation Service and was fortunate to have the opportunity for seven years to manage and direct the post-grazing alpine area restoration program in the Snowy Mountains. This project gave me an even greater appreciation of the need for native plant conservation, as the majority of the restoration works were undertaken in what was to eventually become Kosciuszko National Park.

After this, project was completed I was located for six years with the Ecology Section of CSIRO Division of Plant Industry. Here, I researched impacts of wildfires and fire management practices on alpine flora. I then joined the NSW NPWS as a Research Officer/Botanist where I worked for 35 years on many NPWS research and management programs, all focused on catchment management, soil stability and native plant conservation.

Are you involved in any volunteer plant conservation activities?

I have been the convenor of a Landcare Group for the past eight years, the Group being involved in local woodland and grassland restoration projects. The Group has a plant propagation nursery which provides relaxation for members while contributing native plants to the local rural community.

I am also a member of the Sydney Royal Botanic Gardens Scientific Committee to which I hope to be able to contribute more in the next couple of years.

How long have you been involved with the ANPC? And what do you believe are its key roles?

I have been a member of the ANPC since its establishment in 1991, having been involved in the early discussions and meetings on its formation. I was an ANPC Committee

member for some five years and coordinated and ran several of the early workshops on ecological restoration which the ANPC organised.

I became a member of the ANPC because I had a commitment to the conservation and study of native plants in my professional Public Service positions. I consider the ANPC as one of the leaders in restoration ecology and knowledge transfer, and it has an experienced and knowledgeable membership, as witnessed at the APCC10 conference in Hobart this year.

I have always recognised that effective plant conservation cannot be achieved by the establishment of protected areas alone, but also requires voluntary involvement such as that provided by Non-Government Organisations (NGOs) like the ANPC.

I believe the ANPC should continue to offer specialised training workshops on plant ecology, plant identification, plant conservation techniques etc., particularly at a time when some of these are not available or are increasingly being downgraded or overlooked by tertiary education institutions. Native plant ecology and plant community and ecosystems ecology is still a developing science, particularly within the fields of ecosystem restoration, conservation and management. The ANPC is at the fore and has gained recognition for its promotion of these fields within the wider community.

The ANPC could and should become a stronger voice for native plant species and community conservation and management, from which good publicity for and recognition of the ANPC would accrue. One of the issues facing ANPC is that it is still not well known within the

general community and hence membership is basically only by 'word of mouth'. We need to appeal to a wider audience and hence a greater potential membership. This is a big issue for the ANPC to address, if it is to grow and move forward into some of the big issues of native plant conservation, such as local seasonal weather shift and regional climate change.

What advice would you provide for NGOs trying to secure corporate support in the future?

I was fortunately quite successful over many years in securing corporate funding from utility companies for the conservation and restoration of native vegetation in the Alps. However fundraising is a time consuming and at times very frustrating exercise. To be successful in gaining support and sponsorship, any voluntary/NGO organisation has to have a sponsorship plan and a dedicated working subcommittee or dedicated person to implement it.

There is always the need to 'get within' a corporate company in some way, usually by befriending a person of some influence within a company. It may take several years to build a relationship with individuals within a potential supporting company. Continuous or at least regular liaison with the company is also required to sell your product in a way that appeals. This includes targeting companies who would identify some commercial benefit or would engender community perception that the company has some green credentials, for example, companies with names or products that have native plant names in their products, or an inference of contributing to native plant conservation.

Book review

Ticks and tick-borne diseases – protecting yourself: A review of current information and options for bush regenerators, bush workers and people who love the bush

Edited by Virginia Bear and Lynn Rees.

ISBN 978-0-9923765-1-2.

Published by the Australian Association of Bush Regenerators Inc.

Edition 2, May 2014

Free download from <http://www.aabr.org.au/update-ticks-and-tick-borne-diseases-protecting-yourself-second-edition-now-available/>

And now to Biosecurity of a different sort – protecting yourself against ticks.

I grew up in tick country. My Dad near-collapsed once a few hours after a bite – not full anaphylaxis, but bad enough that we rushed him to hospital. But they had never

bothered me much, just a persistent itchy lump on the odd occasion I picked one up. And, of course, ticks (at least the ones that like humans) are oddly patchy in their distribution around the continent, and vary a lot with season and apparently with what flavour of human they like. So unless you have a history of susceptibility, it's easy to neglect them as a problem, especially when travelling.



Book review (cont.)

It was in the Kimberley in 2005 that I came a cropper. It had been a poor Wet, with lots of fire at the end, so green patches were few. We made camp for a few days and there was a choice of swag sites: ash bed (messy), rock platform (hard), or a little soft patch with some ground cover near the shrub line. Seemed like a good idea at the time. Then on the way out, we spent a day in thick grass hunting for a couple of species. Trips like that in the tropics, you're itchy most of the time anyway, so I didn't pay much attention. By the time we got back to base at Mount Elizabeth Station I had about 200 of the little bastards (thanks Wendy!), nearly all the tiny larval stage that I'd always known as grass ticks. A couple of weeks later, back in Sydney, I was on antibiotics having tested positive for a dose of Spotted Fever, one of the Rickettsia bacterial diseases carried by ticks. Scrub Typhus is another variant. Spotted Fever, according to the authoritative websites, occurs in Queensland and Bass Strait, so I'd like to think my case made for a new spot on the map (sorry), but frankly I don't think the information capture system is that good. It didn't affect me much, the itch from the bites was more of an issue – and after a few weeks I tested negative, good-oh, problem solved.

Three months later I developed persistent rashes on the lower legs, itchy bite sites, and pain and tingling in hand and foot joints. My symptom profile did not correspond well to Lyme disease, the one that everyone has heard about. After the usual mucking about with GPs I got to see the bloke who was said to be the gun on tick diseases – he twiddled his bow tie and couldn't give a diagnosis. Some time after that, I developed a tenderness around the eyes. A very smart GP picked this up and sent me to a good eye specialist who diagnosed the unfortunately named Graves Disease, a thyroid-cycle autoimmune condition caused by autoantibodies that bind to tissues in certain organs, including the eye muscles – it can cause loss of sight. But what caused these antibodies to appear? “The most common cause is an insult to the immune system”, says the doc, “have you been bitten by anything lately?”

After several courses of prednisone and one of radiation, the Graves had receded but not disappeared. Eight years on, and I still have bad leg rashes at night, reduced heat tolerance, and reduced physical stamina. I have got off light compared to some, but it has impacted my life adversely in several ways.

The study of tick-borne diseases in Australia is under-developed, and in recent years has been bedevilled by an extremely unedifying debate over whether or not Lyme disease occurs in Australia. This continues, although it now seems almost certain that at the very least a ‘Lyme-like’ disease does occur here, is transmitted by ticks, and desperately needs less semantics and more targeted research. The editors of this book clearly lean to the pro-Lyme camp but give an objective summary of the state of knowledge. A unfortunate side-effect of the focus on Lyme disease is that even less well-known tick-disease syndromes, including the so-called ‘co-infectives’, have had virtually no attention at all in Australia, so these are inevitably given limited coverage.

Part 1 of the book provides a thorough review of options for tickbite prevention, including permethrin-treated clothing and permethrin washes, and techniques for removing embedded ticks. Manufacturer's claims and any research backing for each method or product are noted but definitive judgments are avoided. Risks are adequately noted, but will need to be assessed further for your particular situation (look up Material Data Safety Sheets for the active compound and other ingredients), and applied in context – the ether-based sprays recommended by some to freeze-dry the tick *in situ* are not something to use next to the campfire.

The second half of the book deals with tick types, tick biology, and tick-borne diseases and allergic responses, and is one of the clearest and most comprehensive plain-English summaries available that I have seen in several years of looking. Final sections outline the range of zoonotic (animal borne) infections of humans, the current bureaucratic wrestling over Lyme, and some current research projects.

Forgive the personal case history above, but it brings me to my point: do ANYTHING possible to reduce the risk of tick-bite. This booklet will tell you how.

Bob Makinson, Royal Botanic Gardens Sydney

Information resources and useful websites

What determines revegetation success?

Online research project of restoration professionals

A research project undertaken by the Environmental Decisions Group at The University of Queensland, is conducting a survey of restoration ecologists, practitioners and researchers across Australia involved in the revegetation of terrestrial native vegetation. The information obtained will provide the restoration community with important insights on the motivations for undertaking revegetation and factors that influence the costs and success of revegetation. The goal is to learn from revegetation practice across diverse sectors, so that the outcomes of revegetation can be improved in the future.

The target audience is restoration ecologists, practitioners and/or researchers from a variety of organisations (government, non-government organisations, community

groups, private organisations, private landholders, universities and research institutes) who are or have been engaged in the revegetation of terrestrial native vegetation in Australia. Revegetation includes any method of reinstating native vegetation on previously cleared lands, including by plantings, seeding, assisted natural regeneration or a combination of these or other methods. The survey is nationwide to capture variation between geographic regions and vegetation types.

If you would like to participate in the survey and be part of a research project that aims to improve revegetation outcomes, please follow this link to the survey:

https://qualtricsasia.qualtrics.com/SE/?SID=SV_2ucsi1pgjQMfXzn

or contact the investigator, Valerie Hagger (Email: v.hagger@uq.edu.au; Phone: 0401 392 704).

Research Roundup

Compiled by Kirsten Cowley

Centre for Plant Biodiversity Research, Canberra. Email: Kirsten.Cowley@csiro.au

de Bie, K. and Vesk, P.A. (2014). **Ecological indicators for assessing management effectiveness: a case study of horse riding in an Alpine National Park.** *Ecological Management & Restoration* 15(3): 215-221. doi: 10.1111/emr.12127

Bonebrake, T.C., Syphard, A.D., Franklin, J., Anderson, K.E., Akcakaya, H.R., Mizerek, T., Winchell, C. and Regan, H.M. (2014). **Fire management, managed relocation, and land conservation options for long-lived obligate seeding plants under global changes in climate, urbanization, and fire regime.** *Conservation Biology* 28(4): 1057-1067. doi: 10.1111/cobi.12253

Connors, B.M. and Cooper, A.B. (2014). **Determining decision thresholds and evaluating indicators when conservation status is measured as a continuum.** *Conservation Biology* doi: 10.1111/cobi.12364

Downes, K.S., Light, M.E., Posta, M., Kohout, L. and van Staden, J. (2014). **Do fire-related cues, including smoke-water, karrikinolide, glyceronitrile and nitrate, stimulate the germination of 17 *Anigozanthos* taxa and *Blancoa canescens* (Haemodoraceae)?** *Australian Journal of Botany* 62: 347-358. doi:10.1071/BT13189

van Etten, E.J.B., Neasham, B. and Dalgleish, S. (2014). **Soil seed banks of fringing salt lake vegetation in arid Western Australia – density, composition and implications for postmine restoration using topsoil.** *Ecological Management & Restoration* 15(3): 239-242. doi: 10.1111/emr.12119

Fearnside, T., Kerruish, B. and Shirley, J. (2014). **Developing a management plan for a small urban woodland.** *Australian Forestry* <http://dx.doi.org/10.1080/00049158.2014.947546>

Fitzsimmons, J.A. and Carr, C.B. (2014). **Conservation covenants on private land: issues with measuring and achieving biodiversity outcomes in Australia.** *Environmental Management* 54: 606-616. doi: 10.1007/s00267-014-0329-4

Garrard, G.E., Bekessy, S.A., McCarthy, M.A., Wintle, B.A. (2014). **Incorporating detectability of threatened species into environmental impact assessment.** *Conservation Biology* doi: 10.1111/cobi.12351

Research Roundup

- Hallfors, M.H., Vaara, E.M., Hyvarinen, M., Oksanen, M., Schulman, L.E., Siipi, H. and Lehvavirta, S. (2014). **Coming to terms with the concept of moving species threatened by climate change – a systematic review of the terminology and definitions.** *PLoS ONE* 9(7): e102979. doi: 10.1371/journal.pone.0102979
- Hewitt, A., Holford, P., Renshaw, A., Haigh, A. and Morris, E.C. (2014). **Population structure, seed loads and flowering phenology in three common (*Melaleuca styphelioides*, *M. thymifolia*, *M. nodosa*) and one rare (*M. deanei*) *Melaleuca* (Myrtaceae) species of the Sydney region.** *Australian Journal of Botany* 62: 286-304. <http://dx.doi.org/10.1071/BT14082>
- Kath, J., le Brocq, A., Leyer, I. and Mosner, E. (2014). **Hydrological and land use determinants of *Eucalyptus camaldulensis* occurrence in floodplain wetlands.** *Austral Ecology* 39: 643-655. doi: 10.1111/aec.12126
- Kodym, A., Clarke, I., Aponte, C., Turner, S., Bunn, E. and Delpratt, J. (2014). **Large-scale micropropagation of the Australian key species *Gahnia radula* (Cyperaceae) and its return to revegetation sites.** *Australian Journal of Botany* 62: 417-427. <http://dx.doi.org/10.1071/BT14091>
- Kuebbing, S.E. and Nunez, M.A. (2014). **Negative, neutral, and positive interactions among nonnative plants: patterns, processes, and management implications.** *Global Change Biology* doi: 10.1111/gcb.12711
- Mishler, B.D., Knerr, N., Gonzalez-Orozco, C.E., Thornhill, A.H., Laffan, S.W. and Miller, J.T. (2014). **Phylogenetic measure of biodiversity and neo- and paleo-endemism in Australian *Acacia*.** *Nature Communications* doi: 10.1038/ncomms5473
- Murphy, H.T., Metcalfe, D.J., Bradford, M.G. and Ford, A.J. (2014). **Community divergence in a tropical forest following a severe cyclone.** *Austral Ecology* 39: 696-709. doi: 10.1111/aec.12133
- Ng, C.F., McCarthy, M.A., Martin, T.G. and Possingham, H.P. (2014). **Determining when to change course in management actions.** *Conservation Biology* doi: 10.1000/cobi.12382
- Nikabadi, S., Bunn, E., Stevens, J., Newman, B., Turner, S.R. and Dixon, K.W. (2014). **Germination responses of four native terrestrial orchids from south-west Western Australia to temperature and light treatments.** *Plant Cell, Tissue and Organ Culture* 118: 559-569. doi: 10.1007/s11240-014-0507-3
- Palmer, W.A., Heard, T.A. and Sheppard, A.W. (2014). **A review of Australian classical biological control of weeds programs and research activities over the past 12 years.** *Biological Control* 52: 271-287. doi: 10.1016/j.biocontrol.2009.07.011
- Pausas, J.G. and Keeley, J.E. (2014). **Evolutionary ecology of resprouting and seeding in fire-prone ecosystems.** *New Phytologist* 204: 55-65. doi: 10.1111/nph.12921
- Pinto, S.M., Pearson, D.E. and Maron, J.L. (2014). **Seed dispersal is more limiting to native grassland diversity than competition or seed predation.** *Journal of Ecology* 102: 1258-1265. doi: 10.1111/1365-2745.12282
- Tozer, M.G. and Ooi, M.K.J. (2014). **Humidity-regulated dormancy onset in the Fabaceae: a conceptual model and its ecological implications for the Australian wattle *Acacia saligna*.** *Annals of Botany* 114: 579-590. doi: 10.1093/aob/mcu144
- Tulloch, A.I.T., Maloney, R.F., Joseph, L.N., Bennett, J.R., Di Fonzo, M.M.I., Probert, W.J.M., O'Connor, S.M., Densen, J.P. and Possingham, H.P. (2014). **Effect of risk aversion on prioritizing conservation projects.** *Conservation Biology* doi: 10.1111/cobi.12386
- Wamelink, G.W.W., Goedhart, P.W. and Frissel, J.Y. (2014). **Why some plant species are rare.** *PLoS ONE* 9(7): e102674. doi: 10.1371/journal.pone.0102674

Plant Germplasm Conservation in Australia

Strategies and guidelines for developing, managing and utilising *ex situ* collections

Fully revised edition 2009 | Edited by C.A. Offord and P.F. Meagher

Full of practical case studies on germplasm conservation including seed collection, banking, germination and dormancy.

For more information and to order, go to <http://www.anpc.asn.au/publications/germplasm.html>

Plant Germplasm
CONSERVATION
in Australia

strategies and guidelines
for developing, managing and utilising
ex situ collections

Edited by Catherine A. Offord and Patricia F. Meagher



The Australian National Plant Conservation Institute (ANPCI) is a partnership with
Australian State Conservation and Research Institutes

AUSCAR



aabr.org.au

Australian Association of Bush Regenerators

Working with natural processes

The Australian Association of Bush Regenerators (AABR) was incorporated in NSW in 1986. It now has several hundred members all over Australia.

Our activities reflect our commitment to promote the study and practice of ecological restoration, and encourage effective management of natural areas.

AABR membership is now open to all interested people and organisations.

Accreditation of experienced practitioners is now offered by AABR as a separate process to membership.

Details of ways to become a member (or to gain practitioner accreditation) are available on our website.



UPCOMING WORKSHOP SERIES

Native plant provenance issues in a changing world DOES IT MATTER?

If you work with Local Land Services, are involved in natural resources management, revegetation/ restoration, conservation, are involved in seed collection, nursery production, landcare or are just interested in working with our declining native plants in an ever changing world, it does matter, and this series of six workshops across NSW is for you.

The workshops will be delivered by plant genetic experts and experienced native plant seed specialists during May 2015. So stay tuned.

Register your expression of interest by contacting Martin Driver, ANPC Project Manager by phone on 0400 170 957 or email on projects@anpc.asn.au. LLS staff and partners can nominate directly to Paul Hutchings by phone on 02 6728 8025 or email on paul.hutchings@lls.nsw.gov.au

Updates and workshop dates and locations will be notified soon.

The importance of "provenance" is about knowledge – knowing where plant seed came from, the site and situation it grew in, the type and form of the plants, is all important to the usefulness and value of the seed. It is also important in conserving the genetic integrity of local native vegetation.



Australian Network for
Plant Conservation Inc



Local Land
Services

